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SENSITIVITY AND TRADE-OFF ANALYSIS OF WAVE MAKING RESISTANCE AND STABILITY OF SMALL WATER PLANE AREA TRIMARANS

by

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September 2007

Thesis Advisor: Fotis Papoulias

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SENSITIVITY AND TRADE-OFF ANALYSIS OF WAVE MAKING RESISTANCE AND STABILITY OF SMALL WATER PLANE AREA TRIMARANS

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ABSTRACT

Recent concept ship designs have called for a vessel with the capability to lift and transport multiple medium displacement combatant boats, approximately 40 to 100 tons, at high speeds over thousands of nautical miles. One such design placed two small water plane area (SWATH) side hulls significantly aft of the center hull transom to facilitate a heavy duty hoist system. This thesis determines the optimal longitudinal and lateral positioning of small water plane area side hulls, and the number of and associated position of struts that would be used in a large displacement small water plane area trimaran design. The analysis explores eighteen different small water plane area side hull configurations to verify through a series of computational fluid dynamics calculations the total resistance and wake characteristics of the overall hull designs. A mathematical analysis of the wave making, frictional, and pressure resistance of each of the hull configurations will be developed using the Rankine Panel Method from the surface wave and flow analysis software package called SWAN2. Static stability and geometry data is generated for the concept design using computer aided design and RHINOMARINE hydrostatic analysis software. A systematic analysis of the results is conducted in order to determine the optimal side hull; separation, longitudinal position, and number of struts for best resistance and static stability which can then be used in a systems engineering process for further study of the feasibility of the use of a small waterplane area trimaran for a concept design.

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I. STUDIES OF ADVANCED VESSEL TECHNOLOGIES

A. INTRODUCTION

The development of new concepts in maritime operations have required naval architects to consider advanced vessels designs unlike any in service today. This report explores the optimization of a unique trimaran ship design based on a high speed displacement center hull with two small water plane area displacement side hulls. This design may be an option for a long range, high speed vessel which has the capability to rapidly load, transport, and deploy multiple medium displacement vessels to forward operating areas where docking facilities are not available. Based on declared operational requirements, this trimaran arrangement may be a viable choice for the next generation of heavy cruisers such as the CG(X) design. The need for a slender trimaran of this configuration is stemmed from the necessity to reduce operational costs such as construction, fuel, and personnel required to operate fleets of ships capable of transiting the Atlantic or Pacific Ocean. Currently vessels that are specifically designed to fight in littoral waters are being unnecessarily oversized due to requirements that they must be able to safely transit the world oceans as well as fight is shallow areas close to shore. Realistic optimization of a littoral mission vessel should allow boats to be truly designed for confined and shallow depth operating areas. A vessel of such capability would not require a long range or deep draft. Without such characteristics though, a littoral mission ship cannot feasibly transit the vast ocean safely, economically, or independently. Due to the lack of sufficient delivery systems, littoral mission ships must be designed to open ocean survivability standards otherwise they must be disassembled and delivered by commercial transport over a course of several weeks. The combination of these handicaps have driven several studies of unique ship designs that can load, transport, and unload a large number of medium sized fully operational crafts without docking facilities in a very short time frame.

The Total Ship Systems Engineering Team at the Naval Postgraduate School in Monterey, California has a design which implements the use of the slender small waterplane area trimaran. The system design was to respond to current maritime threats

based on the need to inspect multiple merchant ships in transit crossing the Pacific Ocean without slowing the flow of commerce. The TSSE Team developed a trimaran hull form that utilized the small water plane area (SWATH) hulls as the side hulls of the ship. The side hulls where located aft of the transom of the center hull to facilitate a fixed 100 Ton overhead hoisting system. This hoisting system would lift one of six 95 Ton patrol and intercept craft into an enclosed mission bay where it would be secured for transit.

B. DEPARTMENT OF DEFENSE FEASIBILITY STUDIES

Over the last few decades, considerable interest has developed for the implementation of high speed shipping. Numerous studies have been performed by commercial, government regulatory, and international shipping organizations to determine the feasibility of current technology in the immediate implementation of high speed freight shipping. Likewise, the U.S. military has initiated several studies into concepts of sea basing such as global fleet station and high speed military sealift. Several of these projects are discussed presenting current national focus towards future designs and establish a basis for the conduct of this thesis study.

1. Marine Transportation Center

The Marine Transportation Center of The University of Alabama in Tuscaloosa, Alabama was under contract from the Department of Defense to study the deployment of commercial transportation technology. This study was completed in 1999 and covered technology not only for trans-oceanic service, but also short distance service markets such as the Caribbean, Mediterranean, North Sea, East, West, and Gulf Coasts of the United States. The focus of this study was primarily to address the major obstacles facing profitable high speed service operations.

a. Principle Findings

The results of the Advanced Vessel Technology report concluded some obvious and not-so-obvious details that need to be addressed to provide high speed water-borne shipping. Details of concern cover such things as; integrated port and docking facilities, advanced ship control systems, and regulatory problems regarding international

classification agencies and civil port authorities [1]. Other concerns discuss operational personnel limitations and hull construction technology [1]. However, the primary barrier addressed is the fact that the cost of fuel to provide high speed ocean-borne shipping is already sufficiently high to jeopardize any such service. One of the principle conclusions is that in order to alleviate the stress of excessively high fuel costs, the development of more efficient propulsion and hull designs must be achieved before service for long and short routes may become profitable and therefore desirable [1].

b. Recommendations

Aside from the recommendations to study crew fatigue, collision avoidance, or high speed ship control systems; the report noted the lack of common hydrodynamic tank testing for the multitude of advanced ship designs. It is noted in the report the need to develop data to help naval architects and marine engineers optimize efficient high speed craft for cargo applications. A matter of concern of high speed service is the need for wake wash data of various advanced hull form to minimize the effect while operating in congested waterways[1]. Unless designs take into account wake reduction, high speed designs will be to the highest degree apposed by fishing fleets and recreational boat users.

2. Center for the Commercial Deployment of Transportation Technologies (CCDoTT)

In February of 2005, the CCDoTT of California State University, Long Beach, California completed a feasibility study that addressed the military need to develop alternative capabilities such as Sea Basing, to operating from allied or coalition territories. Sea Basing is a proposed objective to rapidly move United States military forces into theater and deploy heavier lifting capabilities than can currently lifted by boat or helicopter [2]. The CCDoTT has prepared a report for the Office of Naval Research that outline the design of an aircraft carrier designed to accommodate C-130J operations to support early forcible entry of combat troops with combat vehicles.

The principle drivers of the CCDoTT design for the Heavy Air Lift Seabasing Ship (HALSS) is the requirement to complete a 10,000 nautical mile sea voyage at 35

knots and a greater that 15,000 nautical mile sea voyage at 25 knots without refueling [2]. The HALSS hull form was the result of a correlation between; high speed performance & structural requirements, seakeeping & structural support, and enough volume and deck area for all propulsion options[2].

The 60,000 Ton hull form speed and power prediction results were obtained with the CFD analysis conducted at California State University, Long Beach California and data provided by Naval Surface Warfare Center Carderock Division. The report concluded that it was technically and economically feasible to build and maintain a trimaran in the United States that can support C-130J sea base operations.

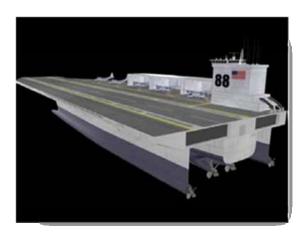


Figure 1. Heavy Air Lift Seabasing Ship (HALSS) [From 2]

3. Naval Postgraduate School: Total Ship Systems Engineering

a. Maritime Threat Response

The design of the Total Ship Systems Engineering Interceptor Carrier was conceived under the idea to create a mothership that not only supports and commands operations of a fleet of smaller vessels, but to also have the ability to launch and recover those vessels in a relatively short period of time in the most common sea conditions of the Northern Pacific [3]. Additional considerations based on the concept of operations included the need to carry the full compliment of interceptors 7,000 nautical miles through the duration of the mission with no replenishment assets available. Based on these needs, the ship design was developed [3].



Figure 2. Total Ship Systems Engineering: Concept Design [From 3]

The Total Ship Systems Engineering Maritime Threat Response Trihybrid Hull, is a unique design concept that comprises of the Trimaran and a catamaran SWATH hull forms. In order to create an open docking area with a fixed arch covering the aft section of the ship, an approximately 120ft long SWATH section is incorporated into the design [3]. This enclosed area makes up the entire loading and unloading area of the ship. By combining the two different and very unique hull forms, the TSSE mothership concept can load and unload a 95 ton interceptor vessel into a mission bay safely and expeditiously using a robust fixed hoist mechanism without the use of complicated, labor-intensive, or highly expensive systems [3].

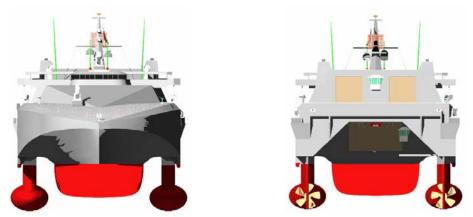


Figure 3. TSSE 2006 Design: Bow and Stern Launch and Recovery View [3]



Figure 4. TSSE 2006 Design: Profile View [3]

4. Trimaran Trailership HSTT-180

A report in Marine Technology Journal conducted in July of 2005 specifically examined the feasibility of using a high speed trimaran with SWATH side hulls to provide service with enough speed, reliability, and economy to draw truck traffic away from the eastern coastal highways. The report presented the advantages and technology development issues offered by the high speed trimaran form. The specific advantages included; multi speed modes where it was very economical hat very high speeds (25 to 40 knots) [4]. This design showed improved wave loading, maneuverability and stability, as well as interoperability, reliability, and insensitivity to weather [4].

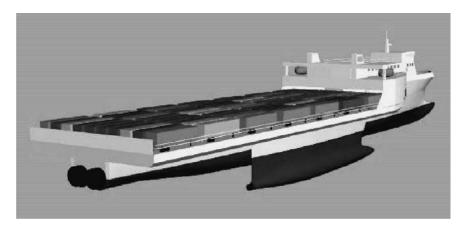


Figure 5. High Speed Trimaran Trailership (HSTT-180) Concept [From 4]

The design technology development issues presented in the report discussed; the learning curve required to build a non-conventional multihull propulsion system and ship

arrangement, trimaran structural loading issues, hydrodynamic effects, wave interactions and scale correlation factors, propulsion systems, and cargo handling systems.

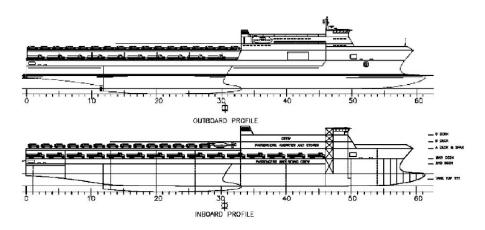


Figure 6. High Speed Trimaran Trailership (HSTT-180) Arrangement [4]

Speed and power predictions for the ship were verified against a series of model tests conducted at the David Taylor Model Basin during a 1999-2003 study of very high speed trimaran designs. With a payload of 2,000 tons, the ship was 8,700 metric tons (8,562 LT) displacement, designed to 181 meters (593 feet) in length a beam of 32.2 meters (105 feet) and an overall draft of 8 meters (26 feet) [4]. For performance data, the report predicted a range of 800 nautical miles at 39.5 knots or 1,800 nautical miles at 26 knots [4].

The final conclusion is that a vessel of the high speed trimaran and SWATH design; primarily constructed of mild-steel, utilizing a combined diesel and gas turbine propulsion systems connected to a series of waterjets, is a viable alternative to coastal highway trucking [4]. From a cost point of view it was concluded that considering the cost of road repair, construction, and safety; coastal express service using the short sea service alternative is a very economical solution to traffic congestion and air pollution [4].

5. Twenty-first Century Heavy Cruiser CG(X)

The growing role of missile defense and sustain joint combat operations is readily apparent in the future of Naval operations. The CG(X) is the Multi-mission follow-on design to the DDG1000 with enhanced Missile Defense / Air Warfare capability and fleet operational sustainment. The primary mission of CG(X) will be to maintain air superiority over the total force [5]. The ability to sustain small fleets of littoral combat vessels as a global fleet station, although initially considered a secondary role, may prove to be a crucial capability in the next stages of the CG(X) concept design, thereby assuring the Navy's major contribution to execution of the National strategy in the 21st century. Additionally, CG(X) will also be required to use many of the transformational technologies used in the DDG1000 design phase to reduce crew size, ship signature, and operating and support costs.

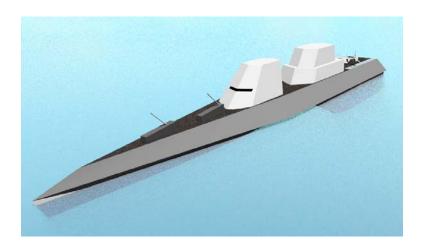


Figure 7. Possible CG(X) Concept Design

Although CG(X) is still in the concept stage, the Navy is taking a hard look at the joint capabilities gaps CG(X) will ultimately fill. The Navy is currently making critical decisions to determine what weapon and sensor systems she will carry, as well as what

littoral command capability she will need [5]. Initial studies are currently working to determine how large CG(X) will need to be to provide the numerous multi-mission capabilities required by sustained Navy operations.

Noting the lessons of recent military operations, adversaries will work to prevent the buildup of US force through access denial strategies [5]. These strategies will include missile attacks or improvised explosives on the infrastructure supporting US power projection (ports, airfields and communications networks), political targets, and of course direct assaults on US military forces [5]. Advanced Theater Ballistic Missiles (TBM), Overland Cruise Missiles (OCM), Unmanned Combat Aerial Vehicles (UCAV), Anti-Ship Cruise Missiles (ASCM) and supporting surveillance and targeting systems pose a rising threat to the ability of US Naval forces to gain and sustain access. A global fleet station or sea base will be necessary to stage, launch, and command future offensive operations directly from the sea. More capable than her predecessors, the CG(X) will provide the umbrella of air and missile defense with larger, faster, and heavier long range missiles, protecting carrier strike groups and the other Naval vessels, as well as counter inland air threats hundreds of miles away [5].

The hull form of the CG(X) along with an advanced propulsion system will need to allow CG(X) to sustain operations with vessels ranging from the CVNs to LCS as well as support forces ashore. With a small waterplane trimaran, the CG(X) may utilize the DDG1000 monohull as the center hull of a larger more capable vessel. Larger and faster, the CG(X) will be not only carry more missiles and weapons systems to counter state-of-the-art air threats hundreds of miles over operating areas ashore, but also perform fleet deployment, command, and control missions well in the littorals. The CG(X) would be quite literally a derivative of the DD(X) design, with more power projection and Naval presence than the DDG1000. The Navy would gain the option of selecting a DDG1000 Hull for CG(X) service in the construction phase if it were deemed necessary and visa versa. Although the CG(X) might be somewhat larger than the DD(X), it would have a procurement cost roughly equal to that of the DDG1000's. The CG(X) would have a full-load displacement of about 15 to 18 thousand tons, compared to about nine thousand tons for current Navy cruisers and destroyers.

C. SUMMARY

In all the sections previously addressed, there is one underlying ship design requirement. All of the reports had established a need by commerce, the Navy, and other branches of the U.S. military to develop a large vessel capable of lifting and deploying fleets of boats, wings of C-130s, and or large volumes of commerce at high speeds over long voyages through the world's seaways. They addressed concept designs that are steering towards the development of a revolutionary hull design. The systems engineering process has established the overall requirement for such a conceptual design and the current level of development is moving beyond the preliminary system design phase.

Numerous studies have been conducted confirming the advanced features of the trimaran. However, due to various reasons such as lack of substantial analytical data, serious weight has not been placed in the system engineering process regarding trimaran designs when conducting the analysis of alternatives. This shows that this report and additional studies such as in this report, will promote the development of alternatives that will prove significant and feasible in the development of highly capable future hull designs.

II. DESIGN SELECTION

A. OVERALL CONCEPT CONFIGURATION

The hull configurations used in the analyses for this report are based on the Naval Postgraduate School Total Ship Systems Engineering Report for Maritime Threat Response in December of 2006. The TSSE design called for a 600 foot center hull with two 300 foot small water plane area side hulls trailing 200 feet aft of the transom of the center hull. This configuration allowed for the incorporation of an open pool between the side hulls to launch and recover medium (approximately 100 ton) sized patrol craft.

B. CENTER HULL DESIGN SELECTION

The concept multi—hull designed by the Total Ship System Engineering 2006 Team incorporated a center hull form similar to the hull form used for the center hull of the Austal 127 trimaran Benchijigua Express [3]. Due to proprietary and classification restrictions exact dimensions could not be used. A suitable example of the Austal 127 trimaran and the center hull of the TSSE design is the Taylor Series 64 high speed round bottom displacement hull, which is approximately similar to the hull design and is used in prediction calculations of this analysis. The Series 64 displacement type hull was selected to for its low-wave-drag performance up to Froude number of Fn = 1.5 [6]. This allowed for relative ease of calculation of total resistance of the center hull. Resistance calculations for the Total Ship Systems Engineering Report use the Holtrop analysis embedded within the AUTOSHIP Ship Design software [3]. In order to reduce the number of configurations in the CFD analysis, only one 600 ft hull with similar lines to the Taylor Series 64 type hull was used.

1. Taylor Series 64 Background

Why model the trimaran with a Taylor Series 64 like hull? The initial tests conducted on the Series 64 model were run up to a Froude number of Fn = 0.60 [6]. However, due to the demand for naval ship designs of increasing speed, tests of the Series 64 hull were run up to Froude number Fn = 1.5 by the David Taylor Research

Center in 1959 [6]. The parameters that are identify as the primary variables are: block coefficient, C_B , length-to-displacement ratio, $L/\nabla^{1/3}$, and beam-to-draft ratio, B/T. To establish initial conditions for the purposes of the tests, the prismatic coefficient C_P was kept constant at 0.63. The distinctive features of the Series 64 model are the heavily raked stem, no bulbous bow, fine entrance angles, and a small transom with a round knuckle. The longitudinal center of buoyancy (LCB) for the Series 64 test models were at 56.6 percent of the length from forward perpendicular [6]. It was found that above Froude number 0.90, the wave resistance is no longer an important factor of the Series 64 hull, frictional resistance is the fully dominant factor. At such high values of Froude numbers, it is necessary to keep the wetted surface to a minimum [6]. For the purposes of the TSSE concept design, and this analysis, the highest Froude number encountered does not exceed 0.45.

2. Hull Series 64 Resistance Characteristics

Due to the large numbers of different types of hull forms in the Series 64, the resistance results for the individual models are generally not referenced. However, the average resistance values for the complete series are available for the initial parametric studies and as consequence can be used as an easy comparison to calculational data [6]. From this data, one can observe the relatively consistent values of residuary resistance up to Froude number 0.45 and therefore assume any significant changes on the test trimaran's residual resistance may be due primarily to the side hull configuration.

The figures below show the general frictional resistance and residual resistance coefficients for the Series 64 high speed displacement center hull based of experimental data [6].

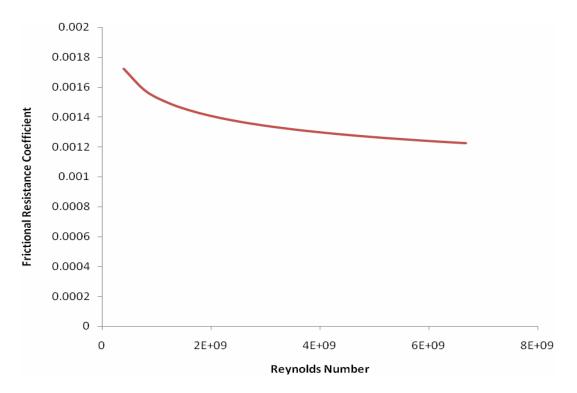


Figure 8. Frictional Resistance Coefficient [6]

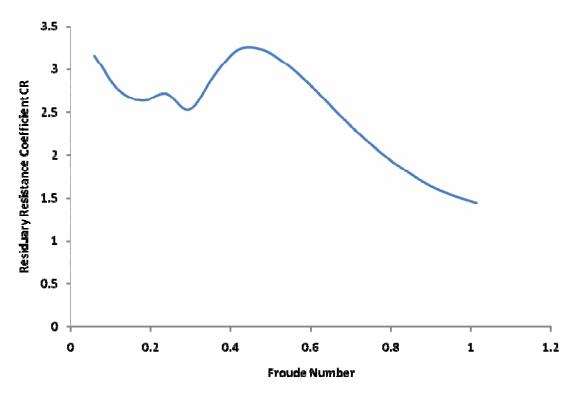


Figure 9. Series 64 Hull Residual Resistance Coefficient [6]

C. SIDE HULL DESIGN SELECTION

In order to facilitate the design requirements of the stern section of the TSSE Maritime Threat Response ship, a catamaran configuration was implemented using two small water plane area side hulls (SWATH hulls). The TSSE ship's overall design was one where the forward section, purely a conventional trimran, transitioned into a trimaran with SWATH hulls between the ship's 570 to 660 foot perpendiculars, then further trainsition into a conventional SWATH catamaran at the stern. This configuration allowed the TSSE team to incorporate into their design an open pool near the longitudinal center of buoyancy of the ship to facilitate the heavy lifting operations required of the 100 ton patrol and intercept crafts used in their mission [3].

1. Submerged Side Hull Design

Each submerged hull of the side hull design is an ellipsoidal body with an elliptical cross-section. The submerged side hull or pod as it is sometimes referred, is composed of three main sections. The first section is the bow section, the second section is the parallel body, and the third section is the after body [7]. The cross section of the pod is an ellipse with its major axis horizontal at 28 feet and its minor axis vertical at 20 feet. For this analysis the bow consists of half an ellipsoid with the major axis at 75 ft. The after body is also half an ellipsoid with its major axis at 150 feet. The parallel body section is 75 feet between the bow and after body.

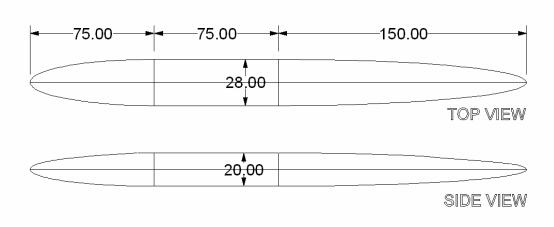


Figure 10. Submerged Side Pod Geometry

Based on the research conducted in reference 2, the geometry for the underwater section of the SWATH is typically similar to the geometry of a submarine. The following variable define the shape of the submerged pod,

D = equivalent diameter

L = pod length

 L_f = bow section length

 L_a = after section length

 L_{mb} = parallel mid section length

 n_f = forward shape factor

 n_a = after shape factor

The shape factor coefficients, where 0 < n < 1.0, are dependant on the volume of hull that is within the volume which is enclosed by a straight cylinder of length L_f or L_a and diameter D respective to the bow or afterbody. The more bluff the body is, the higher the coefficient of the shape factor, the more streamlined the body is, the lower the coefficient shape factor [7].

2. Strut Selection Background

There continues to be a debate amongst the SWATH ship designers about the advantage or disadvantage of using a single strut per side versus using multiple struts per side [8]. In 1976 the David Taylor Research Center conducted seakeeping experiments on a series of SWATH models. These experiments consisted of two configurations that were single strut design and a third configuration that was a tandem strut design. All three configurations had equal waterplane areas. The first configuration had the lowest GML of 20 ft and shortest struts. The second configuration had longer struts and a slightly higher GML of 38 ft. The third configuration with the tandem struts had the highest GML of 45 ft. Additionally, all three designs showed the same characteristics of

heave and pitch motion [8]. Based on these results the DTRC concluded that the hydrostatic characteristics have a greater effect on SWATH seakeeping than whether each hull has one or two struts [8].

Although SWATH ships have approximately 75% larger wetted surface areas than their equivalent displacement monohulls, SWATH design benefit from reduced wave resistance characteristics [6]. The reduction in wave resistance is directly correlated to the slenderness of the struts. However, careful attention has to be directed to the required depth submergence of the hulls and the possible unfavorable interactions between the wake systems developed by the struts. As a rule of thumb, the submerged hull depth below the surface should be greater or equal to the diameter of the hull. Since the level of detail required for full analytic wave making resistance predictions is generally not available in early stages of design, tandem and multi-strut configurations are generally avoided. This may lead to needlessly dropping a design that given proper attention would prove to be the most effective.

3. Strut Design and Placement

The finding the proper placement of the struts is one of the key objectives of this report. In order to simplify the problem, all struts for two or three strut configurations are assumed to be identical vertical elliptical hydrofoils with the same length and thickness. The single strut configuration is however the full length of the submerged pod with the same maximum thickness as the struts used for multi-strut configurations. The multi-strut configurations have struts placed at the extreme ends of the submerged pods. The three strut configuration places an additional strut centered 150 feet aft of the bow of the submerged hull. With exception to the single strut, each of the multi strut dimensions are 60 ft long and 8 ft wide at their maximum thickness. The single strut configuration is 300 ft long and 8 ft wide at its maximum thickness. This design facilitated ease of analysis of the multi strut designs in the SWAN2 software, since each strut length would be 20% of the side hull length.

III. SIMULATION MODELS

A. HULL PLACEMENTS & SHIP CONFIGURATIONS

In order to obtain the optimal ship design, eighteen different configurations were established for each stage of the modeling simulation process with three variables modified between them; the number of struts for the side hulls, longitudinal position, and lateral positions of the side hull referenced from the center hull. Table 1 shows the list of configurations and the associated variables. Note that the X position is normalized to the length of the center hull then referenced from 20 meters aft of the center hull transom. The Y variable normalized to the center hull length and is referenced from the centerline of the center hull to the centerline of the side hull. Only two strut configurations are show in the figures below for brevity

Table 1. Modeling Configurations and Variables

Configuration	Number of Struts	X-Reference	Y-Raference
CONDITION 1-1	1	0	0.048
CONDITION 1-2	1	0.9	0.046
CONDITION 1-3	1	0.25	0.048
CONDITION 1-4	1	0	0.048
CONDITION 1-5	1	0.8	0.048
CONDITION 1-8	1	0.25	0.048
CONDITION 2-1	2	0	0.048
CONDITION 2-2	2	08	0 046
CONDITION 2-3	2	0.25	0.048
CONDITION 2-4	2	0	0.040
CONDITION 2-5	2	0.8	0.048
CONDITION 2-8	2	0.25	0.048
CONDITION 3-1	3	0	0.016
CONDITION 3-2	3	0.8	0.046
CONDITION 3-3	3	0.25	0.046
CONDITION 3-4	3	0	0.048
CONDITION 3-5	3	0.8	0.048
CONDITION 3-8	3	0.25	0.048

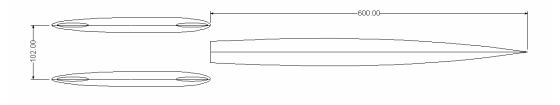


Figure 11. Condition 2-1 Arrangement

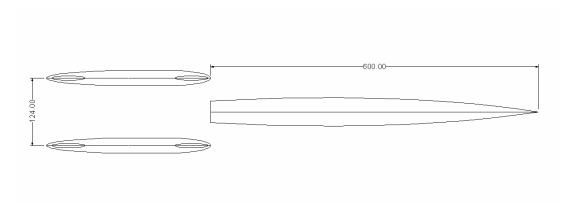


Figure 12. Condition 2-4 Arrangement

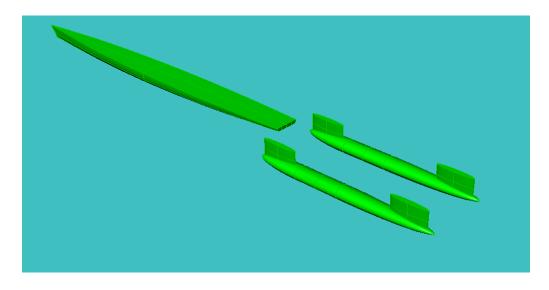


Figure 13. Perspective View of Condition 2-1 & Condition 2-4

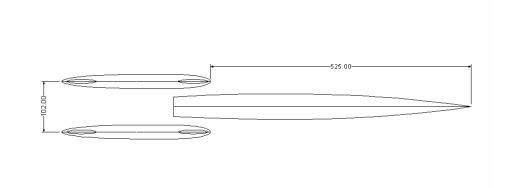


Figure 14. Condition 2-2 Arrangement

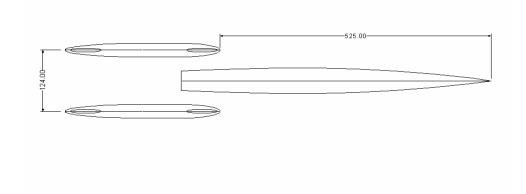


Figure 15. Condition 2-5 Arrangement

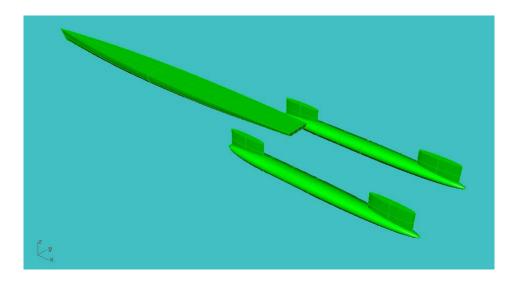


Figure 16. Perspective View of Condition 2-2 & Condition 2-5

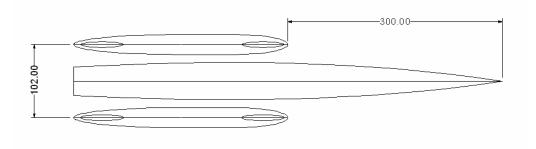


Figure 17. Condition 2-3 Arrangement

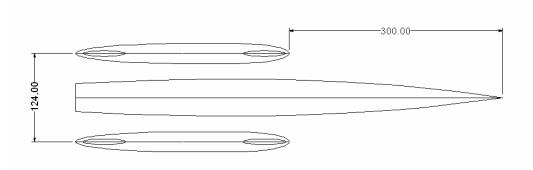


Figure 18. Condition 2-6 Arrangement

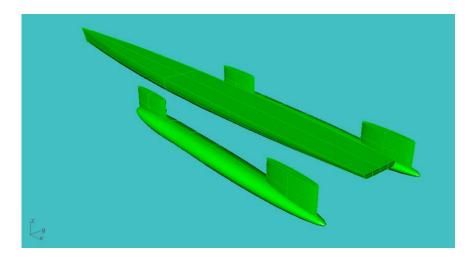


Figure 19. Perspective View of Condition 2-3 & Condition 2-6

IV. THEORY

A. COMPUTATIONAL IDEAL FLOW EQUATIONS

1. Surface Panel Theory

The position of the free surface surrounding a floating body is defined by the state variables; wave elevation $\zeta(x,y,t)$ and velocity potential $\Phi(x,t)$ [9], [10], [11]. The state variables are related by the kinematic condition and the dynamic condition of the airwater interface. The kinematic condition is based on the assumption that the molecules of water and molecules of air that were in contact at the surface at t = 0, stay in contact with each other at all times [9], [10]. The following equation for translation is;

$$\left[\frac{\partial}{\partial t} - \left(\vec{U} - \nabla\Phi\right) \cdot \nabla\right] \zeta = \frac{\partial\Phi}{\partial z} \tag{1.1}$$

Where z is a function of wave elevation. The dynamic condition is based on the assumption that the fluid pressure at the surface of the water must be equal to the ambient atmospheric pressure [9], [10]. From Bernoulli's equation the pressure changes from point to point;

$$\left[\frac{\partial}{\partial t} - \vec{U} \cdot \nabla\right] \Phi + 0.5 (\nabla \Phi) \cdot (\nabla \Phi) = -g\zeta \tag{1.2}$$

On the surface of the ship hull, the normal component of the flow velocity corresponds to the rigid boundary of the hull. Thus the unit vector \hat{n} is the instantaneous position of the ship hull. Additionally, the vector \hat{v} is the oscillatory velocity of the ship hull due to wave induced motion.

$$\frac{\partial \Phi}{\partial \hat{n}} = \vec{U} \cdot \hat{n} + \vec{v} \cdot \hat{n} \tag{1.3}$$

The numerical solution that satisfies the Laplace equation, kinematic condition, dynamic condition, and ship hull boundary condition is in fact the challenging task that only in recent years has computing power been able to manage.

B. RANKINE PANEL METHOD

The Rankine Panel Method described in this section is implemented as the basis of the programming code for the SWAN analysis. The early versions of the SWAN code were tested against simple wave disturbances where exact solutions existed to validate the performance of the analysis. Further experiments were carried out in the latter stages of the algorithm design for simple thin ships and submerged bodies that too were validated by known solutions [11]. Recent versions of the SWAN analysis code have proved against numerous test models at the various research facilities throughout the country.

1. Formulation of Green's Integral Equations

The solution of the surface wave analysis required a strict enforcement of the Laplace equation to ensure continuity of the fluid flow is satisfied [11], [12], [13], [14]. To accomplish this, Green's theorem for the velocity potential and Rankine source potential is applied for the fluid domain bounded by the mean translating position of the ship hull H and by the z = 0 plane, denoted by J [11].

$$G\left(\vec{x};\vec{\xi}\right) = \frac{1}{2\pi \left|\vec{x} - \vec{\xi}\right|} \tag{1.4}$$

Green's Identity is an integral relation between the value and the normal derivative of the yet unknown disturbance velocity potential φ over the surfaces H and J;

$$\varphi(\vec{x},t) + \iint_{H+J} \varphi(\vec{\xi},t) \frac{\partial G}{\partial \hat{n}_{\xi}} (\vec{x};\vec{\xi}) d\xi - \iint_{H+J} \frac{\partial \varphi(\vec{\xi},t)}{\partial \hat{n}_{\xi}} G(\vec{x};\vec{\xi}) d\xi = 0$$
 (1.5)

As $x \to \infty$ for a fixed value of ξ , the contribution from a closing surface at infinity vanishes due to decay of $\varphi(x)$ and $G(x,\xi)$. Over the entire surface H, $\varphi(\vec{x},t)$ is known. The linearized form of the free surface conditions relate the disturbance velocity potential normal vector on the hull surface to the disturbance of the velocity potential normal vector on the water surface J [11].

2. Discretization

Based on models of symmetry, the surfaces H and J are subdivided in half along the ship centerline, and then further subdivided into an extensive number of quadrilateral panels [11]. A bi-quadratic spline variation is assumed for (φ, ζ) of the form,

$$\varphi(\vec{x},t) \cong \sum_{j} (\varphi)_{j}(t) K_{j}(\vec{x})$$
(1.6)

$$\zeta(\vec{x},t) \cong \sum (\zeta)_{i}(t) K_{i}(\vec{x})$$
 (1.7)

where $K_j(x, y)$ is the basis function centered at the j-th panel and provides the continuity between panels and the tangential gradient.

For the Rankine Panel Method, the progression of time is carried out analytically through steady-state or time-harmonic flow through a time derivative [11]. The approximation between the time derivatives and state variables is made through the Euler step sequencing, where N = time step;

$$\left(\frac{\partial \varphi}{\partial t}\right)^{N} \cong \frac{\varphi^{N+1} - \varphi^{N}}{\Delta t} \tag{1.8}$$

By assuming a stationary hull and a positive flow around the hull and subsequently above the free surface, a better model of flow potential is created [11]. From the Bernoulli equation for wave elevation;

$$\zeta_0 = \frac{U}{g} \frac{\partial \varphi_0}{\partial x} - \frac{1}{2g} \nabla \varphi_0 \cdot \nabla \varphi_0 \tag{1.9}$$

Through substituting the Euler step sequencing equation and the Green's Identity equation into the linearized form of the Bernoulli equation, a mixture of the explicit and implicit methods are used in the kinematic and dynamic solutions [9], [10], [11].

C. SINGLE HULL RESISTANCE THEORY

The resistance of a ship is the required force to tow that ship through smooth water at a given speed. The total resistance of a ship is made up of five main components; frictional resistance, wave-making resistance, flow turbulence resistance, form drag, and air resistance [15]. Frictional resistance and form drag can be categorized into Viscous resistance. Wave-making, air, and flow turbulence resistance make up the residual resistance category. Calculation of Resistance is based on the appropriate coefficient of resistance where;

$$R_{TOTAL} = C_T \frac{1}{2} \rho SV^2 \tag{1.10}$$

 $R_{TOTAL} = Total Resistance$

 C_T = Total Coefficient of Resistance

 ρ = Density of the immersed fluid

S = Total Wetted Surface Area

V = Velocity of the vessel

The total coefficient of resistance is the sum of the five main resistance coefficients.

$$C_{T} = C_{friction} + C_{wave} + C_{turbulence} + C_{form} + C_{air}$$
 (1.11)

The following sections discuss the calculations of the required coefficients of resistance and the errors associated with them.

1. Viscous Resistance

a. Frictional Resistance

Viscous resistance which includes frictional resistance and form drag, is due to the motion of the hull through a viscous fluid [15]. The magnitude of the frictional resistance is based on the wetted surface of the hull. Most of the theory governing frictional resistance promulgate from Froude's smooth plank experiments on friction [6]. His resultant empirical formula is;

$$R = fSV^n \tag{1.12}$$

R = resistance, kN or lb

S = total area of surface, m²

V = speed, m/sec

The most commonly used formulation for frictional resistance is the ITTC 1957 Line and is generally agreed as adequate for initial estimations of resistance [15]. Use of the ITTC line requires the addition of the correlation allowance which is shown in the table below.

$$C_f = \frac{0.075}{\left(\log_{10} \text{Re} - 2\right)^2} + C_A \tag{1.13}$$

Table 2.	Correlation Allowa	ince with ITTC line [29]
Ship leng	th on waterline	Correlation allowance
Meters	Feet	C_{A}
50-150	160-490	0.0004
150-210	490-690	0.0002
210-260	690-850	0.0001
260-300	850-980	0
300-350	980-1,150	-0.0001
350-450	1,150-1,480	-0.00025

b. Form Drag

The magnitude of form drag (coefficient of pressure drag) is based on the slenderness of the hull and its appendages. The form drag is a developed from the formation of the boundary layer and the inevitable flow separation. If the curvature near the stern becomes too abrupt, the water can no longer follow the shape of the hull and therefore separates. Separation of this kind affects the overall pressure distribution of the hull and therefore introduces discontinuities into the stream lines of the flow [6].

If we were to use turbulent boundary layer theory, we know that flat-plate flow turbulent profiles are very nearly logarithmic. If we would assume the logarithmic overlap law for turbulent flow holds throughout the layer [16];

$$\frac{V}{u^*} \approx \frac{1}{0.41} \ln \frac{\delta u^*}{v} + 5.0$$

$$u^* = \left(\frac{\tau_w}{\rho}\right)^{1/2} \tag{1.14}$$

 δ = outer edge of the boundary layer

 τ = shear stress along the wall of the hull

v = kinematic viscosity

If we take the skin friction definition to be:

$$c_f = \frac{2\tau_w}{\rho V^2} = 0.73 \frac{1}{\sqrt{\text{Re}}}$$
 (1.15)

We therefore have a skin friction identity that can be used as a crude method of predicting form drag. The table below list a few values as they pertain to hull calculations.

$$\left(\frac{2}{c_{fd}}\right)^{1/2} \approx 2.44 \ln \left[\text{Re}\left(\frac{c_{fd}}{2}\right)^{1/2}\right] + 5.0$$
 (1.16)

Table 3. Form Drag based of Turbulent Boundary Theory

Re	10^{5}	10^{6}	10^{7}	10^{8}	10^{9}	10^{10}
C_{fd}	0.003145	0.002167	0.001577	0.001196	0.000937	0.000752

It must be stressed that the accuracy of using this method is questionable since truly accurate means of calculating turbulent boundary layers has yet to be discovered. The accepted method for predicting ship resistance is from a model that is based on the Froude assumptions where total resistance is divided into frictional and residuary resistance [15]. However, models must be made to very close tolerances and without proper turbulent stimulation, any model test may be misleading. For 99.9% of all cases the true value of form drag is based solely on actual model tank test results. Such is

the case for Series 64 hulls. Since thousands of tests have already been completed on a multitude of hull designs, the form drag, C_P, can be found tabulated in any number of references such as reference 13 of this report.

Some methods of prediction for bodies of revolution have also been presented however, they too hold some ambiguity for the same reason as for surface hull calculations. These methods are solely based on curve fitting of actual tank test results and provide a foundation to initial concept design calculations. The following equation can be used to predict form drag of a submerged body of revolution using the variables defined in the previous section regarding body geometry [7];

$$C_{fd} = \frac{0.00789D}{L_{MB} + L_f C_{wsf} + L_a C_{wsa}}$$
(1.17)

2. Wave Resistance

The classical development of ship wave characteristics was done by Lord Kelvin in the late 17th century. He showed that the system of waves generated by a moving disturbance consists of a series of transverse waves and diverging waves. Based on the derivations of Newton's second law we can derive a general differential equation for wave motion of any type [16]. Now if we consider two waves and the principles of superposition for waves, the algebraic sum of the two waves traveling through a medium produce a resultant wave [16]. However, the wave system developed by a moving ship is not merely two waves, it can consist of an infinite number of wave systems generated by every minor change in curvature of the hull.

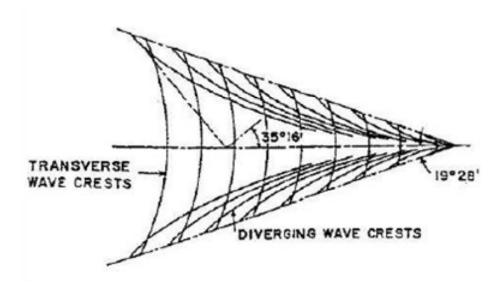


Figure 20. Kelvin Ship's Wake Systems [6]

The waves around a ship are created by the pressure field generated by the ship moving through the water. If we consider an unsteady incompressible and frictionless flow of a fluid, we can apply Bernoulli's equation to a body in a fluid in order to get the pressure force around it. However, due to the dramatic effect of flow separation and the subsequent breakdown of boundary layer theory, actual laminar and turbulent boundary layer pressure distributions are significantly different from those predicted by theory [19].

The wave system produced by a moving ship is so complex that there is as yet no theoretical mathematical model that can accurately represent it with sufficient realism to facilitate calculations of wave-making resistance [6]. The current process of numerically developing a solution for wave resistance as discussed in the previous section, is the only process close enough to accurately depict measurements conducted through towed tank testing.

3. Air & Wind Resistance

Although air and wind resistance is a major part of a ships overall powering calculations, in-depth discussion of this will be omitted from this report and left for further research. Calculations of Shaft Horsepower per tone will be based on the

assumption of constant coefficient of air & wind resistance. The table below provides some common values of air resistance for various vessel types. These coefficients are applied to the equation for air resistance, where $A_{transverse}$ is the assumed projected transverse area above the waterline [15];

$$A_{transverse} = \frac{Beam^2}{2} \tag{1.18}$$

$$R_{air} = C_{air} \left(\frac{1}{2} \rho A_{transverse} V^2 \right)$$
 (1.19)

Table 4. Still Air Resistance Coefficient [15]

Ship Type	Coefficent Range
Combatant	0.40 to 0.80
Passenger	0.65 to 1.10
Container	0.60 to 0.75
Tanker	0.75 to 1.05
General Cargo	0.60 to 0.85

D. MULTI-HULL THEORY

The process to develop a reasonable solution to the frictional resistance from a trimaran are not unlike those for single hull theory. Common practice is to calculate the resistance for each individual hull which make up the trimaran and through proper proportioning add their respective coefficients. A major concern with trimaran design is the interference between the hulls. In the modern studies of trimarans, methods have been developed to predict the residuary resistance due to interference of the side hull with the center hull. When the concept development stage predictions of the resistance of trimarans were initially performed, residual resistance was generally over-estimated. However, studies conducted within the last five years have developed extensive measurements of the total resistance of the entire trimaran which has shown lower and

more tangible values of resistance for these types of ships. In fact in some cases, based on side hull location, resistance could be reduced comparable to the monohull with equivalent displacement.

1. Multi-Hull Viscous Resistance

a. Combined Frictional Resistance

Since side hulls are typically less than 40% of the length of the center hull and typically less than 30% of the overall wetted surface, and therefore have different Reynold's Numbers and different Froude Numbers, a separate frictional resistance has to be determined for each side hull and center hull [17], [18]. Because the actual resistance of an object at a given speed is dependant on the coefficient of resistance and its respective surface area, it is possible to combine the C_F for the side hulls and center hull at the same speed proportional to the ratio of their wetted surface.

$$C_{F_{TOTAL}} = C_{F_{CENTER}} \left(\frac{S_{CENTER}}{S_{TOTAL}} \right) + C_{F_{SIDE}} \left(\frac{2 \times S_{SIDE}}{S_{TOTAL}} \right)$$
 (1.20)

Just as for mono-hull calculations, the ITTC 1957 Line for the coefficient of resistance is applied to the center hull and each individual side hull. The total resistance is the summed coefficients proportional to the ratio of each hull's wetted area to combined wetted area.

b. Frictional Resistance of Submerged Pods

The use of a small water plane area side hull provides an advantage and some simplicity to frictional calculations. Barring extremely complicated hull forms, typical submerged hull are relatively easy to calculate. Two techniques are used to get initial resistance predictions for the submerged bodies. The first and more complicated technique is a mathematical flow analysis using superposition of the elementary plane potential flows for; uniform stream, source, and sink flows known as the Rankine Oval. The stream function is then simply written into a MATLAB code and plotted as functions of the coordinates. The resistance is then taken by integrating the stream function over the entire surface of the body.

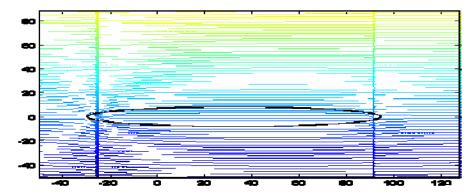


Figure 21. Rankine Oval for Submerged Hull for MATLAB flow analysis

The other technique, and generally the simpler of the two, is through calculating the resistance based on the International Towing Tank Conference (ITTC) curve similar to calculating for a surfaced body.

c. Form Drag

There remains difficulty in the evaluation of the form drag of any hull and especially the interaction of multiple hulls. Form Drag is a function of the boundary layer, flow separation, and circulation around the body. When bodies are in close proximity, boundary layers, circulation systems, and eddy formations take on a whole new characteristic. There are numerous small tanks associated with educational and research establishments currently examining the resistance and interference effects of a trimaran hull system [6].

The validity of computational flow programs has been a subject of controversy in the distant past. Numerous studies since the year 2000 have provided proof of validity for programs that use the Rankine Panel Method and other such methods. They have shown that the necessary computation method of measuring residual resistance consists of predicting the observable shape of the wave system astern of the model and computing its energy. The SWAN program used in this analysis is design to accomplish this process.

2. Residuary Resistance

a. Obstacles of Residual Resistance

The resistance of standard ship designs has been addressed for many centuries. Numerous models are currently available to accurately predict the total resistance that a ship will produce. The purpose of this report is not to re-examine these methods of calculating the frictional resistance, or residual resistance of a monohull, nor is it to elaborate on the resistance of fully submerged hulls such as those for a submarine or Small Waterplane Area Twin Hull ship. In fact there are more than enough simplified and proven calculational methods that accomplish this.

Although wave and turbulent flow resistance is more difficult to predict, nonetheless the computing power of modern computers and recent computational methods of finite analysis has provided accurate solutions for simple monohull, catamaran, and submerged body designs. However, a factor that cannot be simply calculated is the wave resistance and turbulence that develops due to the close interaction of hull forms and tandem appendages. Only within the last few years have wave resistant calculations for trimarans been addressed and made available to academic institutions. In fact, a large amount of computing power and therefore, a high cost is required to develop a reasonable solution to residual resistance, which in general is not always easily accessible.

b. Recent Developments

Due to the lack of extensive prediction models, the Total Ship Systems Engineering Teams and various university ship concept design teams have only been able to make rough monohull and submerged body engineering calculations. The question stands though, do these types of calculations become invalid when the ship consists of multiple types of hulls? Does just adding the results of each separate resultant coefficient equate to a true representation of the ship? This report explores these questions.

Within the past decade, numerous studies been conducted to find an optimized resistance solution for a trimaran. Only a few have been conducted with SWATH side hulls. A study of a Heavy Air Lift Seabasing Ship (HALSS) conducted by California State University and the Office of Naval Research provided some analytical results from computational fluid dynamic analysis which provided some insight into the feasibility of large displacement trimarans and the need to providing further development. There findings showed no significant increase in required propulsion power [2]. This report will provide some insight regarding close hull interactions and allow for more refined parametric study of highly advanced hull forms.

Various computational models have recently been developed for the trimaran due to the recent US Navy acquisition of the Littoral Combat Ship from AUSTAL Corporation. AUSTAL has been developing, building, and continuously advancing the multi-hull ship design for decades and only recently has the Navy developed interest in these advanced types of hulls [19], [20], [21]. In addition to the Navy, commercial shipping companies are beginning to look towards high speed hull forms that can ferry large amounts of cargo at relatively high speeds [1], [20].

3. Optimized Trimaran Hulls

Previous studies of the optimized trimaran configuration where completed by Ronald W. Yeung et al, in a Society of Naval Architecture and Marine Engineering report in 2004. The study consisted of numerous trimarans that used three identical 36 meter Wigley hulls in each configuration whose positions were varied by side hull stagger and separation. The report concluded that the optimal configuration at 12 m/s is a side hull separation SP = 19.23 m and side hull stagger ST = -40.61 m [19]. This places the side hulls significantly aft of the center hull. The optimal trimaran configuration reduced wave drag of the equivalent mono-hull by 88.5%.

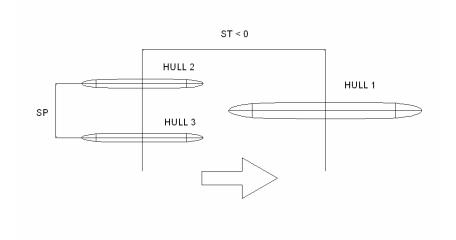


Figure 22. Wigley Trimaran Configuration

In addition to the position of the side hulls in reference to the center hull, the proportioning of the distribution of volume between the three hulls was also analyzed in Yeung's report. The optimized volumes of the trimaran were distributed as 44.2% total displacement contained in the center hull and 27.9% of the displacement in each side hull [19]. The results of this study showed a considerable reduction in the total resistance of the ship even though there was a considerable increase in wetted surface area, the optimization of wave drag actually improved to overall performance of the ship.

The results of the Yeung report show a 60.7% reduction in wave resistance of the trimaran over an equivalent mono-hull. Even when including the increase in frictional

resistance, the results still show a 25% reduction of the total resistance of the ship. The defined dimensions from Yeung's analysis of the three hulls of the trimaran are as follows;

Length: Hull 1 =
$$(1 - 2p)^{1/3}$$
 EQL Hull 2,3 = $(p)^{1/3}$ EQL Beam: Hull 1 = $(1 - 2p)^{1/3}$ EQB Hull 2,3 = $(p)^{1/3}$ EQB Draft: Hull 1 = $(1 - 2p)^{1/3}$ EQT Hull 2,3 = $(p)^{1/3}$ EQT Displacement: Hull 1 = $(1 - 2p)$ EQD Hull 2,3 = (p) EQD

The value of p is a scaling factor where, $0 \le p \le 0.5$. The values of EQL, EQB, EQT, and EQD are the mono-hull equivalent length, bean, draft, and displacement respectively. If these findings are scale able to large vessels, a trimaran ship whose equivalent mono-hull is 15,000 LT, length 800 ft, beam 60 ft, and draft 25 ft would have the following dimensions;

Length:	Hull $1 = 606 \text{ ft}$	Hull $2,3 = 522$ ft
Beam:	Hull $1 = 45$ ft	Hull $2,3 = 39$ ft
Draft:	Hull $1 = 19$ ft	Hull $2,3 = 16$ ft
Displacement:	Hull $1 = 6630 \text{LT}$	Hull $2,3 = 4183 LT$

With these dimensions, a design of this magnitude may not be feasible, since for an 800 ft long ship the overall beam would scale approximately to a whopping 427ft. Not only do these dimensions exist outside the currently available docking and port facilities, but also it would prove to be a significant structural design problem and alleviate any reasonable design margin. From the results it would seem that the maximum applicable length is roughly 250 ft which would have a beam of 134 ft, the equivalent to the waterline beam of Nimitz Class Aircraft Carriers. The trimaran design prescribed by Yeung's report may not be applicable to the larger trimaran designs that concept reports have designated as feasible to naval operations.

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V. SHIP WAVE SIMULATIONS

A. SWAN2 PROGRAM OVERVIEW

The SWAN (Ship Wave ANalysis) software is a computational fluid dynamic program that sweeps a bi-quadratic variation of the velocity potential over a series of panels, permitting computation of flow velocity as part of a dynamics solution [11]. Basically, it is for the analysis of the steady and unsteady zero-speed and forward-speed free surface flows past ships which are stationary or cruising in water of infinite or finite depth or in a channel [11]. The SWAN program solves the steady and unsteady free-surface potential flow problems around ships using a three-dimensional Rankine Panel Method in the time domain by distribution of quadrilateral panels over the ship hull and the free surface. SWAN-2002 calculates the vessels ideal fluid resistance; sinkage and trim motions while translating through calm water, by invoking the boundary conditions presented by the user and solving the equations of motion [11].

The SWAN-2 program requires a text file input, called the PLN file, which contains a list of the X-Y-Z coordinates of the offsets of a particular center hull design. The specific PLN file for this analysis is enclosed in Appendix C. The side hulls are however generated by the programming code embedded in the SWAN software and executed through the MAKESSG.EXE file. The approximate geometries of the ellipsoidal side hulls for this analysis are generated from the following equation;

$$Y_N = (1 - X_N^4) \times \sqrt{R^2 - (Z_N - Z_{REF})^2}$$
 (1.21)

The SWAN program uses the normalized values of the side hull and references them to the overall dimensions of the center hull. The program considers a ship advancing with a time dependant forward speed U(t) in ambient waves. The fluid flow equations of motion are stated with respect to a Cartesian coordinate system P = (x,y,z) translating with velocity U(t) in the positive x-direction. The origin of the coordinate

system is taken on the calm surface which coincides with the user defined mid-ship, center line, and at the design waterline plane z = 0. By assuming a potential flow, the disturbance of fluid velocity v(x,t) is defined as the gradient of the velocity potential $\Phi(x,t)$.

$$Velocity = \nabla \Phi \tag{1.22}$$

As a subsequent result of the satisfaction of continuity, $\Phi(x,t)$ is subject to the Laplace equation $\nabla^2 \Phi = 0$ in the fluid domain. The position of the free surface is defined by the wave elevation $\zeta(x,y,t)$, which along with the velocity potential $\Phi(x,t)$ are the state variable to be determined by the Rankine Panel Method [11].

The panel mesh is generated by routines internal to SWAN-2, which are designed to ensure that all stability criteria are met [11]. The ship hull is input to SWAN-2 in the form of offsets generated by any CAD program. Output from SWAN-2 may be viewed by the TECHPLOT package licensed by AMTEC Engineering. The internal panel mesh generation routine of SWAN-2 distributes panels over the mean free surface and the body surface of the ship hull. The mesh density and the extent of the free surface discretization may be specified by the user, but must be selected carefully. The internal stability analysis routine of SWAN-2 provides the optimal time step for the time integration of equation of free surface and body motion so that the mesh specified by the user meets the SWAN-2 stability criteria.

B. MODEL SETUP

The SWAN simulation program allows for the input of various types of crafts. The wave resistance analysis for the TSSE ship was performed using the trimaran MAKESSG.EXE functions of the program. The hull offset file (PLN) is converted into the spline sheet geometry file (SSG) that contains the panel mesh distribution on the free surface and the body surface of the hull. This is done via the program MAKESSG.EXE. The panel density and domain size are specified by the user via the job control parameters input file (INP). Presently the mesh generation routine supports monohulls, catamarans, trimarans and SES vessels.

The SWAN programming code does contain some limitations on trimaran hull configurations. Notably, the mid-position of the side hulls can not be placed aft of the defined mid ships position of the center hull. Later versions of SWAN (as yet not available to date) are to contain modifications to the code which will allow the user to have additional longitudinal range to position side hulls aft of the ship [11]. To compensate for this limitation in this analysis, the X-Y-Z coordinates of the center hull offsets were artificially adjusted to create a "tail" equal in ship's length aft of the transom. This created a form that doubled the length, at the waterline, of the ship and allowed the side hulls to be position aft of the actual ship form. It was assumed by the author that any additional disturbance to the flow from this "tail" would be significantly less than that generated by the ship.

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VI. RESISTANCE RESULTS

A. HULL WAVE RESISTANCE

In the following sections, the results of the resistance calculations are presented. The first section presents the comparison of wave resistance between the side hulls where the number of struts is fixed. Section 2 compares results with side hull separation position are fixed. Section 3 presents the results where the longitudinal position is fixed. Discussion of the data extracted from these plots is reserved for the final analysis of alternatives and subsequent conclusions in the following chapters.

Single Strut Configuration

1. Number of Struts

0.16

0.2

- - CenterHull

0.0015 0.0005

Figure 23. Single Strut Wave Resistance

0.28

Froude Number (Fn)

Condition 3

0.36

0.4

0.32

Condition 4

0.24

Double-Strut Configuration

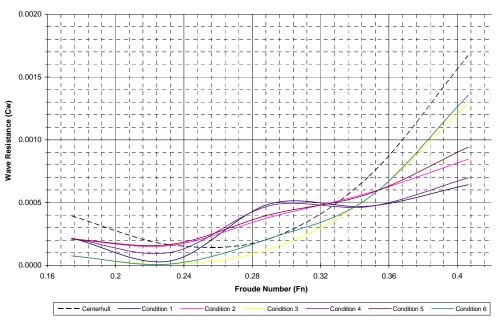


Figure 24. Double Strut Wave Resistance

Triple Strut Configuration

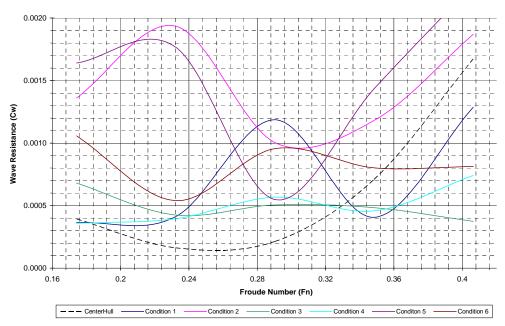


Figure 25. Triple Strut Wave Resistance

2. Side Hull Separation



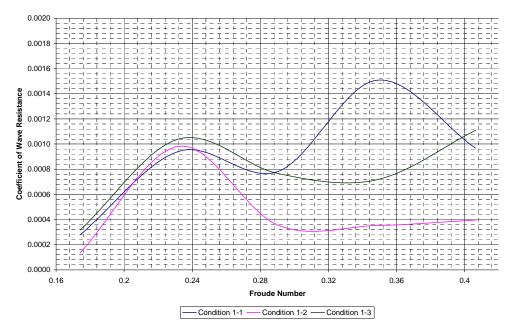


Figure 26. Single Strut Resistance at a Lateral Separation of 4.6% of Centerhull Length

2 Strut - Resistance at Lateral Separation 4.6%

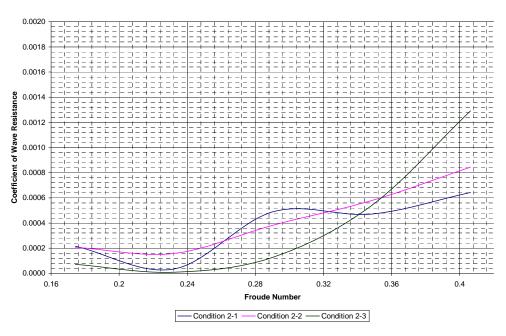


Figure 27. Two Strut Resistance at a Lateral Separation of 4.6% of Centerhull Length

3 Strut - Resistance at Lateral Separation 4.6%

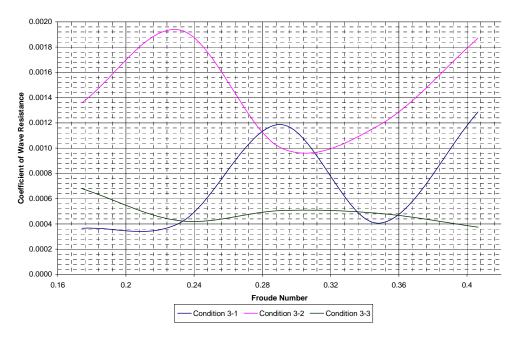


Figure 28. Three Strut Resistance at a Lateral Separation of 4.6% of Centerhull Length

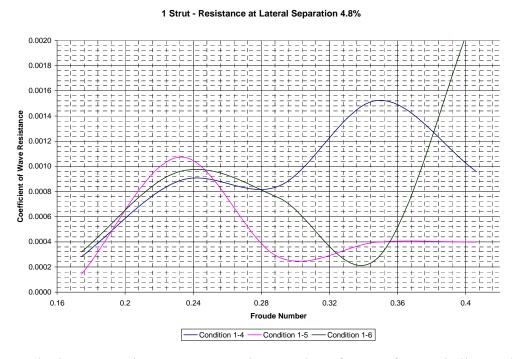


Figure 29. Single Strut Resistance at a Lateral Separation of 4.8% of Centerhull Length

2 Strut - Resistance at Lateral Separation 4.8%

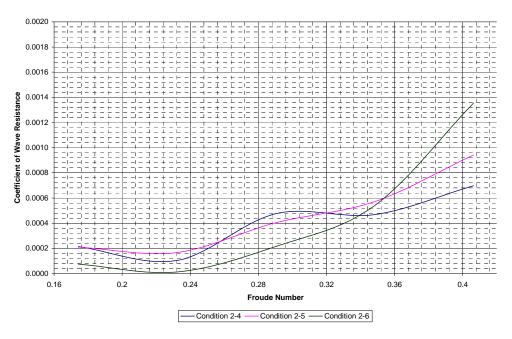


Figure 30. Two Strut Resistance at a Lateral Separation of 4.8% of Centerhull Length

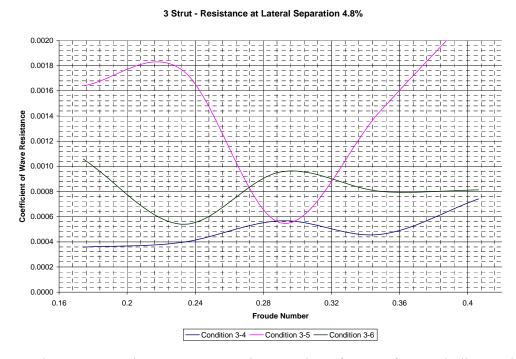


Figure 31. Three Strut Resistance at a Lateral Separation of 4.8% of Centerhull Length

3. Side Hull Longitudinal Position

Condition 3-1

Condition 2-1

Condition 2-4

Condition 1-1 -

Figure 32. Wave Resistance for All Strut Combinations at a Longitudinal Position X = 0

Condition 3-4

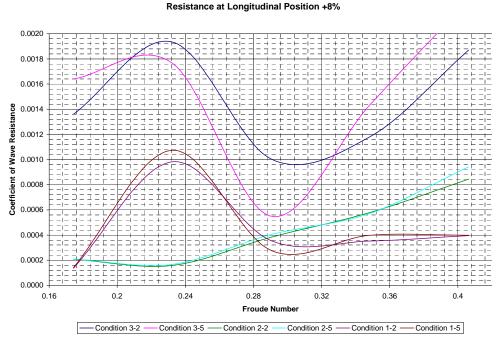


Figure 33. Wave Resistance for All Strut Combinations at a Longitudinal Position 8% of the Length of the Centerhull forward of the Transom.

46

Resistance at Longitudinal Position at +25%

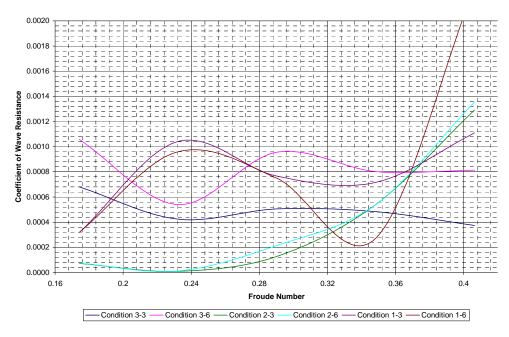


Figure 34. Wave Resistance for All Strut Combinations at a Longitudinal Position 25% of the Length of the Centerhull forward of the Transom.

B. TOTAL CALCULATED RESISTANCE

This section presents the individual calculated resistance of the eighteen different hull configurations. The total resistance includes the combined Wave Resistance, Frictional Resistance of both the center and side hulls, and Pressure Resistance of both the center and side hulls. The data extracted from these plots is one of the inputs into the system engineering analysis of alternatives and provides the basis for the subsequent conclusions in the following chapters.

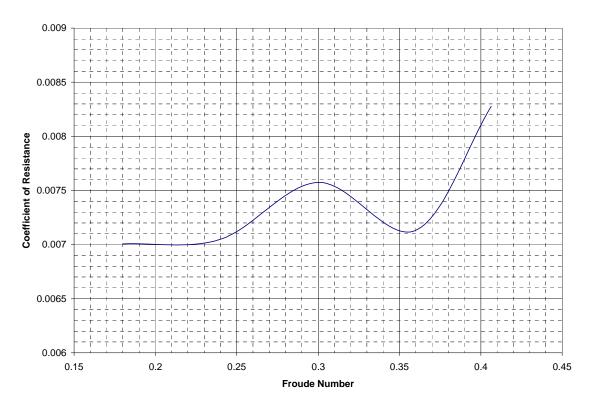


Figure 35. Coefficient of Total Resistance Condition 3-1

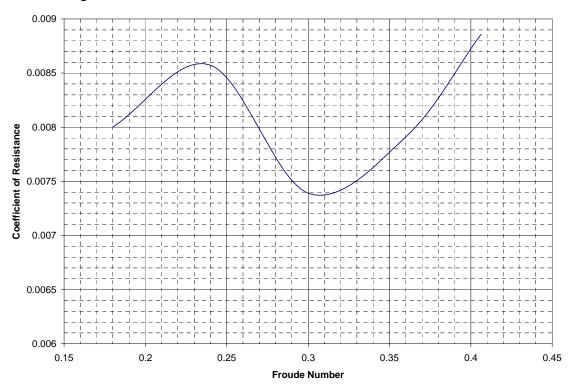


Figure 36. Total Coefficient of Resistance for Condition 3-2

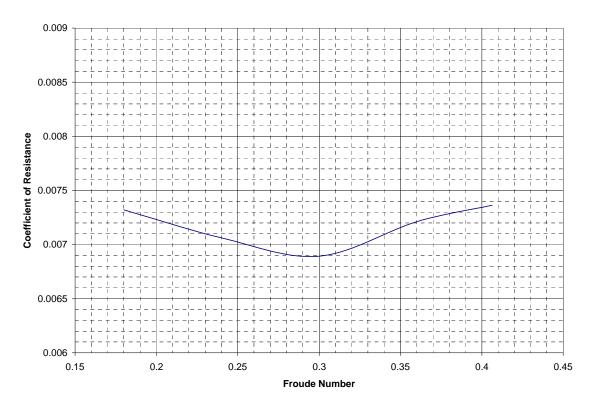


Figure 37. Total Coefficient of Resistance for Condition 3-3

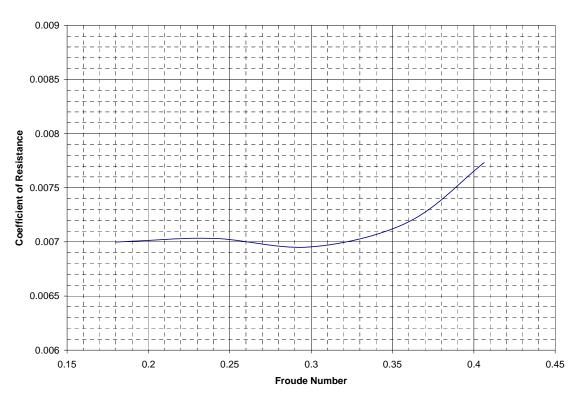


Figure 38. Total Coefficient of Resistance for Condition 3-4

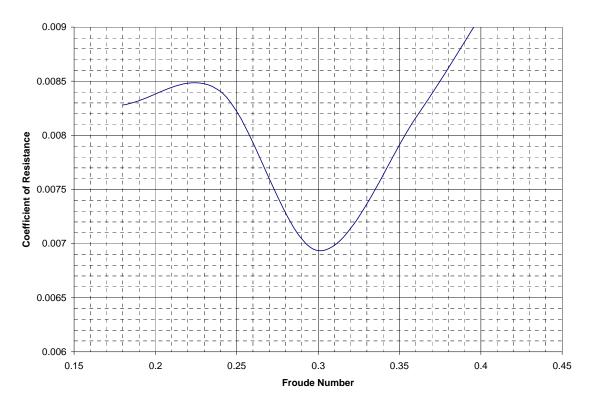


Figure 39. Total Coefficient of Resistance for Condition 3-5

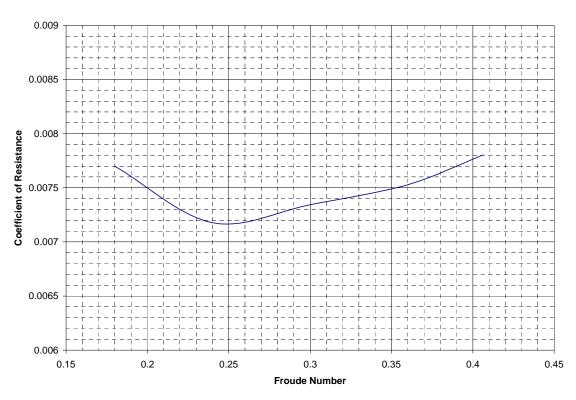


Figure 40. Total Coefficient of Resistance for Condition 3-6

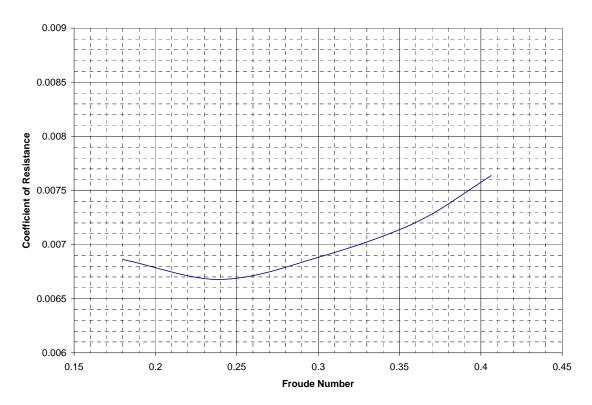


Figure 41. Total Coefficient of Resistance for Condition 2-1

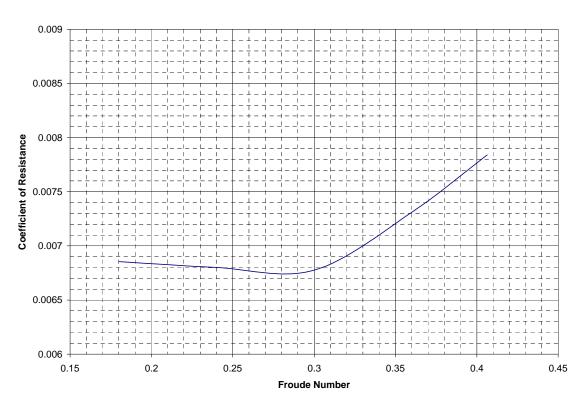


Figure 42. Total Coefficient of Resistance for Condition 2-2

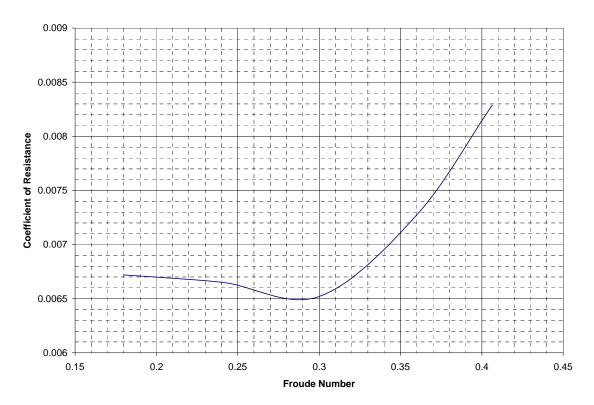


Figure 43. Total Coefficient of Resistance for Condition 2-3

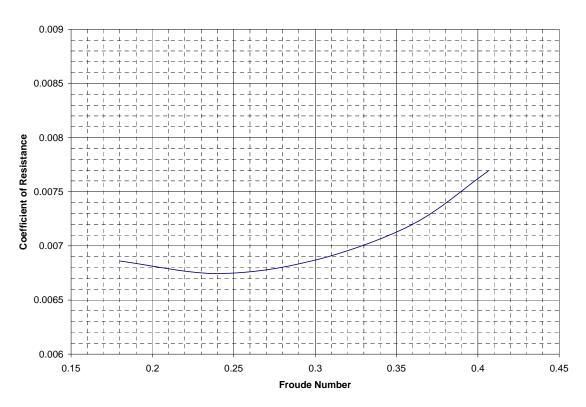


Figure 44. Total Coefficient of Resistance for Condition 2-4

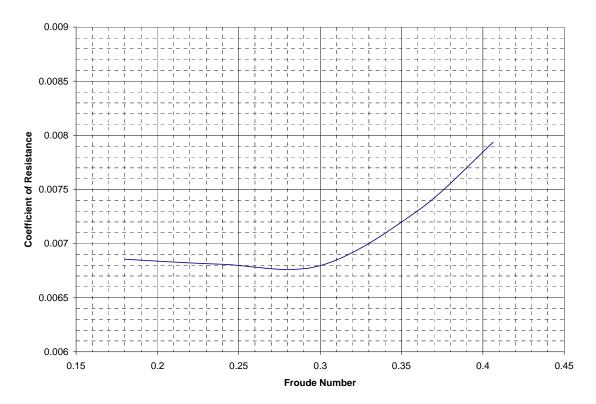


Figure 45. Total Coefficient of Resistance for Condition 2-5

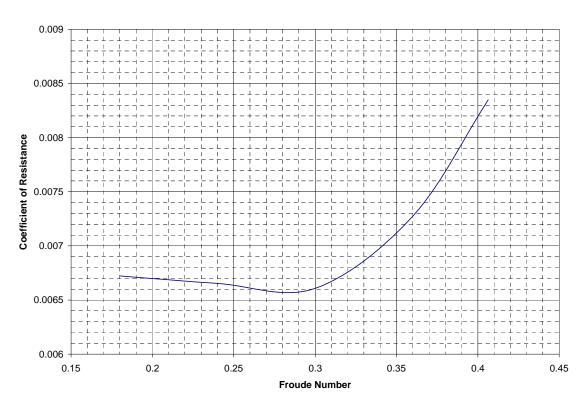


Figure 46. Total Coefficient of Resistance for Condition 2-6

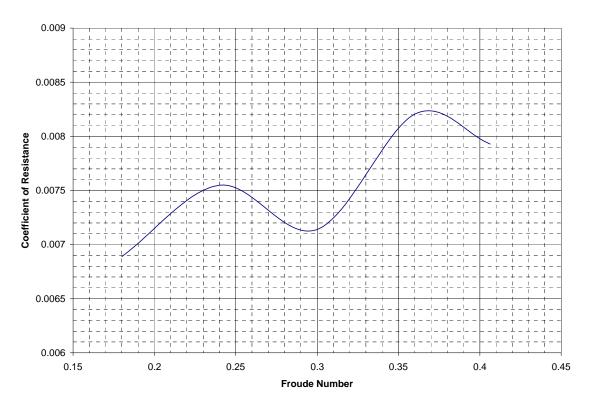


Figure 47. Total Coefficient of Resistance for Condition 1-1

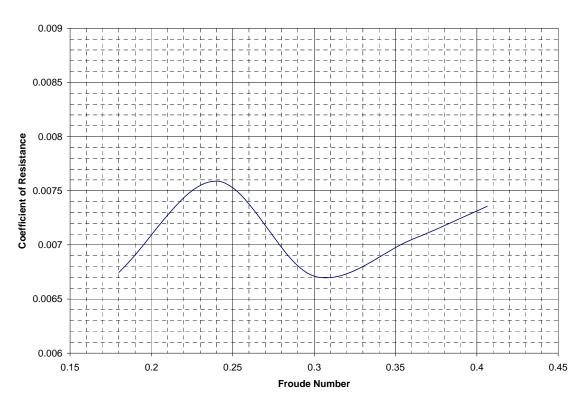


Figure 48. Total Coefficient of Resistance for Condition 1-2

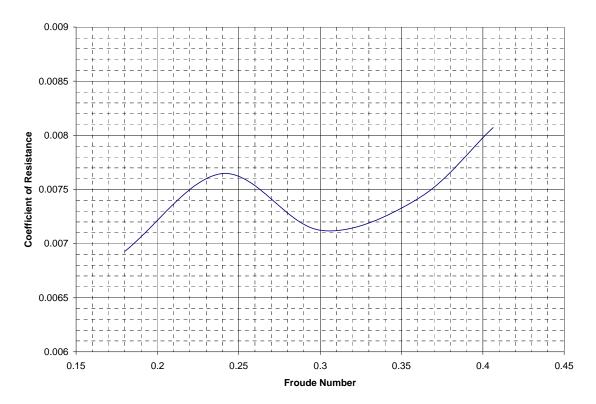


Figure 49. Total Coefficient of Resistance for Condition 1-3

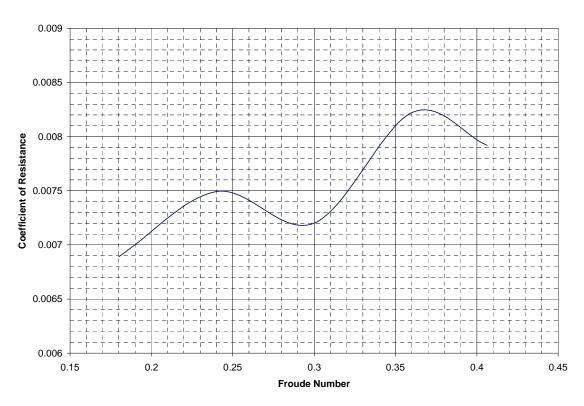


Figure 50. Total Coefficient of Resistance for Condition 1-4

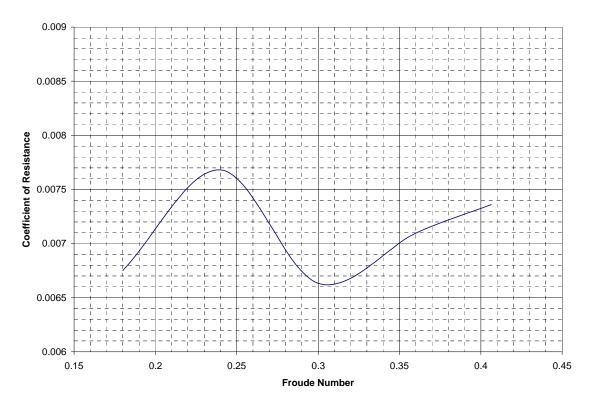


Figure 51. Total Coefficient of Resistance for Condition 1-5

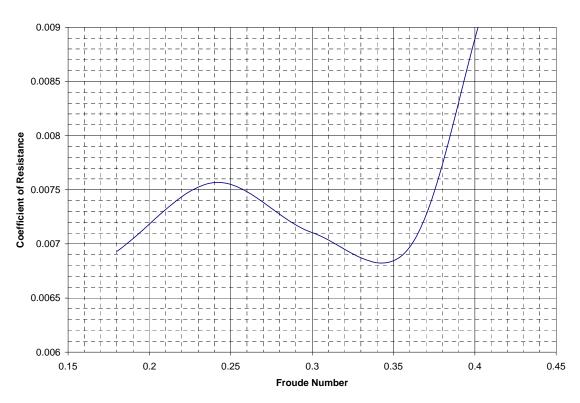


Figure 52. Total Coefficient of Resistance for Condition 1-6

C. PERFORMANCE RESULTS

From the resistance calculations, and given an assumed value for Propulsive efficiency, air resistance, and open water conditions; the shaft horsepower per ton curves for each of the eighteen hull conditions are presented. For all conditions a propulsive efficiency of 0.70 was assumed. Additionally an air resistance coefficient of 0.60 is assumed based on a combatant ship type. For each of the hull configurations, only the Froude numbers corresponding for speeds between 15 and 35 knots are presented.

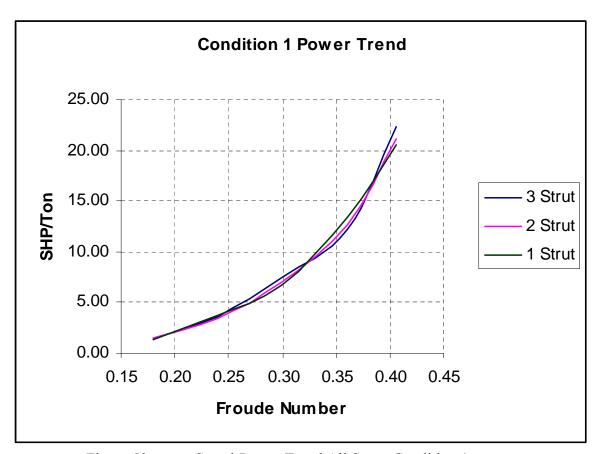


Figure 53. Speed-Power Trend All Struts Condition 1

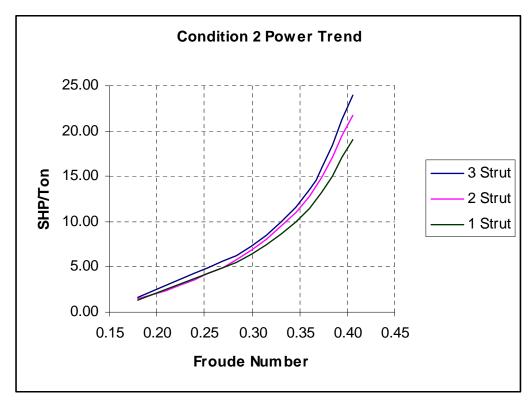


Figure 54. Speed-Power Trend All Struts Condition 2

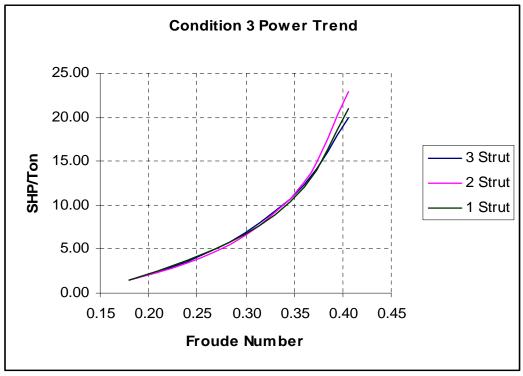


Figure 55. Speed-Power Trend All Struts Condition 3

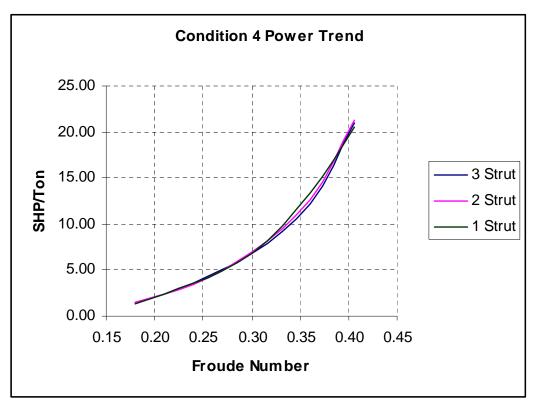


Figure 56. Speed-Power Trend All Struts Condition 4

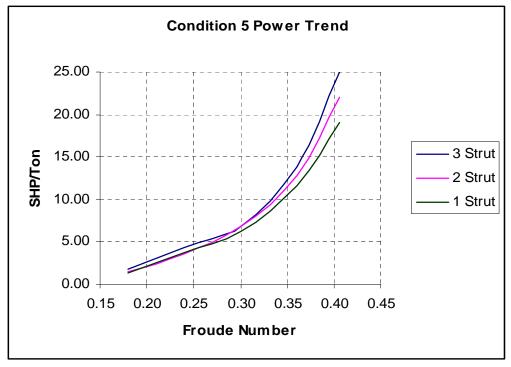


Figure 57. Speed-Power Trend All Struts Condition 5

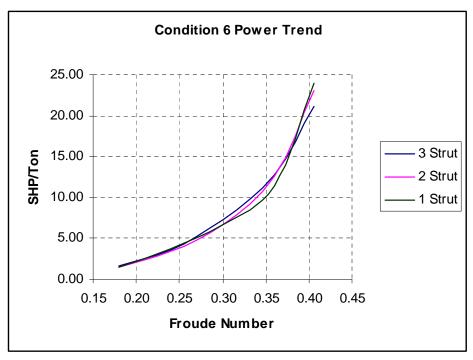


Figure 58. Speed-Power Trend All Struts Condition 6

D. STATISTICAL ANALYSIS OF RESULTS

In order to simplify the number of variables needed for an effective analysis of alternatives, the average values (mean) of the total resistance over the 15 to 35 knot span is taken. Additionally, the maximum value of coefficient of resistance and range of data is presented and ranked in order from least to greatest. Discussion of this data will be reserved for the conclusions derived from the analysis of alternatives which will determine the most effective hull configuration.

AVERAGE SHAFT HORESEPOWER PER TON

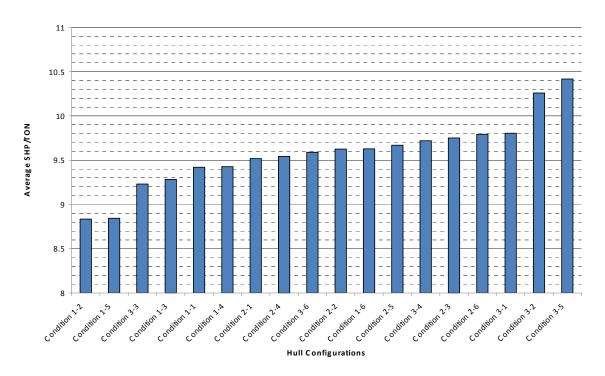


Figure 59. Average SHP/Ton of Each Condition for Speeds 15 to 35 knots

MAXIMUM SHP/TON

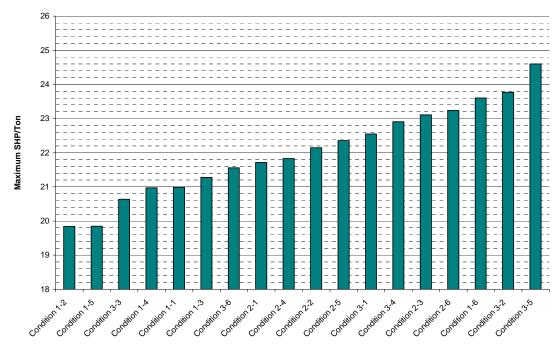


Figure 60. Maximum Resistance Coefficient Experienced and Ranking

RANGE OF RESISTANCE

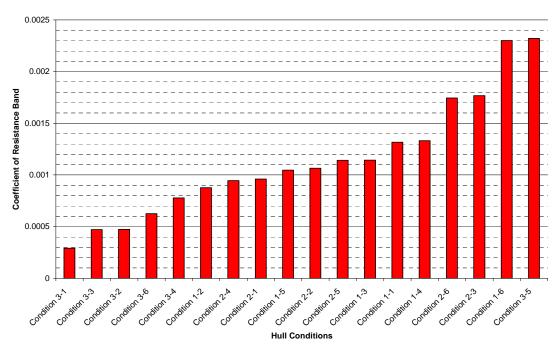


Figure 61. Range of the Coefficient of Resistance for All Configurations

VII. WAKE FORMS & INTERFERENCE

A. DISCUSSION

It is necessary to address the developed wake form of the analyzed results. Designs of vessels which are proposed to operate in congested areas, within harbors or ports, need to effectively minimize wake development. By using the principles of superposition, one would infer that by properly positioning the side hulls of a trimaran, the wave system developed by the side hulls would decrease the wake system of the center hull. However, by misplacing the side hulls, an amplification of the wake system may be a danger.

B. WAKE RESULTS

The following section present the graphical results of the wave resistance analysis. Each configuration presents a unique pattern of wake development based on the Kelvin Wake system. The maximum wave height at 15 knots and at 35 knots is used in the final analysis of alternatives to determine the optimal hull configuration of the eighteen different hulls.

Condition 1-1 through 1-6 utilized the single strut configuration placed at three different longitudinal positions and two different lateral positions with respect to the center hull. At 15 knots there appears to be not enough perturbation of the surface to develop a Kelvin Wake system. However at 20 knots the Kelvin Wake system is apparent and intact. A smooth area exists at the transom with a localized wake. The Kelvin wake system is clear and moderate for the entire ship at 25 knots and is maintained through higher speeds.

Condition 2-1 through 2-6 utilize two tandem struts for the hull configurations and the individual struts are placed at either end of the side hull submerged pods. Due to the relatively low waterplane area of the two strut configuration, it would appear there is very little interaction between the side hull wave systems and the center hull main wave systems. As it would be expected, the simulation results show that there is little perturbation of the surface at all speeds. These configurations provide the least amount

of constructive and/or destructive interferences with the centerhull wake systems. The characteristic resistance profile based on the wake generation is readily apparent in the wave resistance profile curves of the previous chapter.

Condition 3-1 through 3-6 utilize three inline struts for each side hull and are evenly distributed along the hull. Intuitively, the three strut configuration would be expected to perturb the center hull wave systems the most of the three hull configurations. The wave interference is readily apparent in the graphical output of each simulation. However, it cannot be concluded that three struts will generate the most wave resistance. From the graphics, one can observe there are more perturbations on the surface however, their magnitude is low. We can conclude that even though there are more wave systems, they may be interacting in a way to provide constructive interference and thereby reducing the overall resistance of the trimaran. The final analysis of alternatives will examine this phenomenon and determine the optimal condition.

1. Single Strut Side Hulls

a. Condition 1-1 Wake Interference Analysis

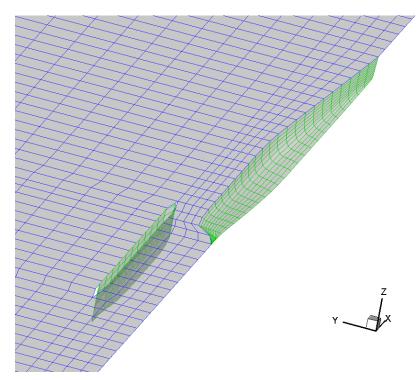


Figure 62. SWAN2 Hull Analysis Mesh for Condition 1-1

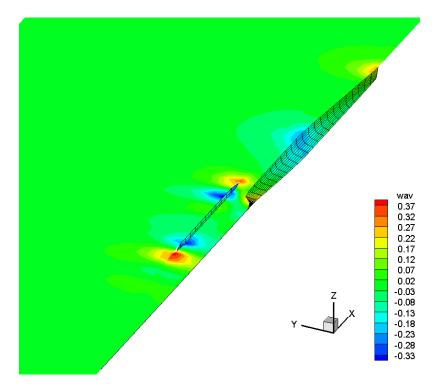


Figure 63. Condition 1-1 Wake Interference at 15 kts

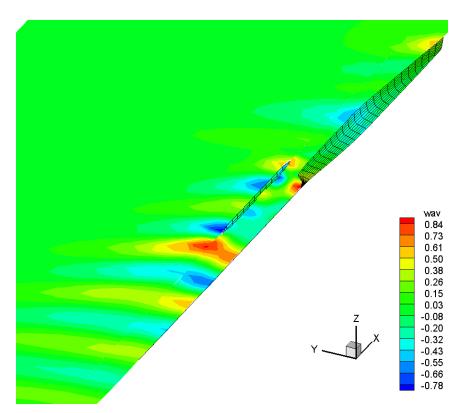


Figure 64. Condition 1-1 Wake Interference at 20 kts

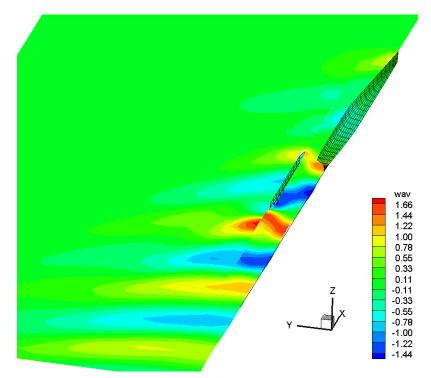


Figure 65. Condition 1-1 Wake Interference at 25 kts

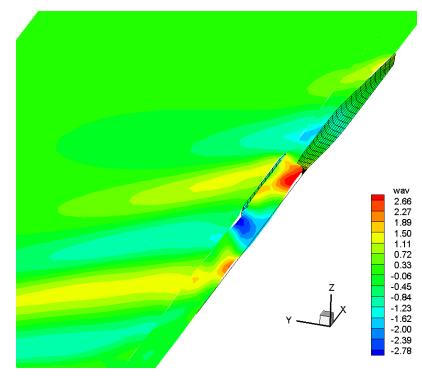


Figure 66. Condition 1-1 Wake Interference at 30 kts

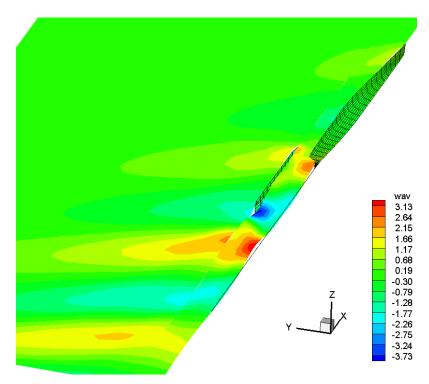


Figure 67. Condition 1-1 Wake Interference at 35 kts

b. Condition 1-2 Wake Interference Analysis

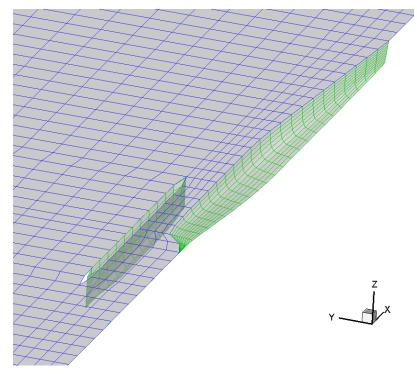


Figure 68. SWAN2 Hull Analysis Mesh Condition 1-2

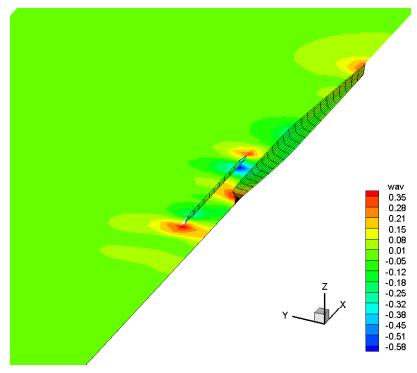


Figure 69. Condition 1-2 Wake Interference at 15 kts 68

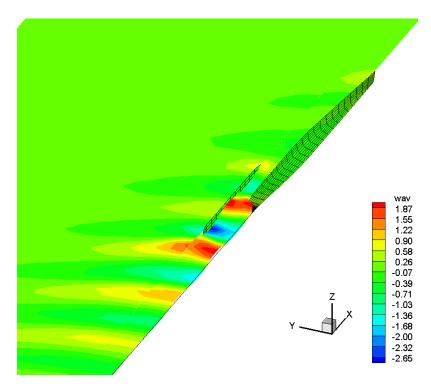


Figure 70. Condition 1-2 Wake Interference at 20 kts

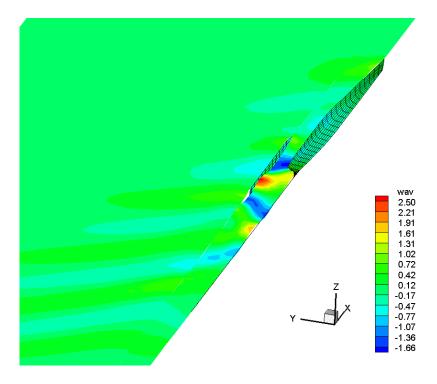


Figure 71. Condition 1-2 Wake Interference at 25 kts

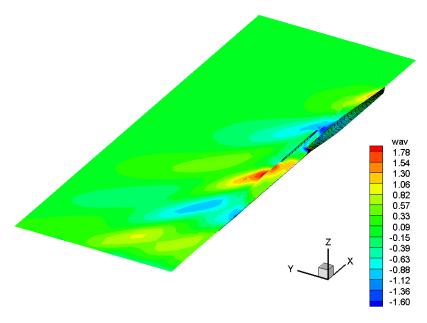


Figure 72. Condition 1-2 Wake Interference at 30 kts

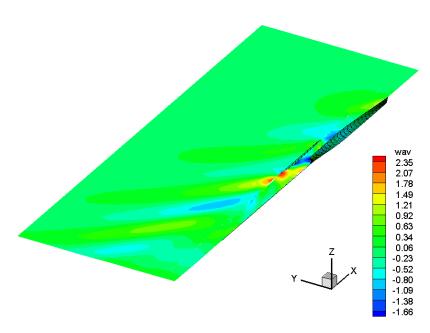


Figure 73. Condition 1-2 Wake Interference at 35 kts

c. Condition 1-3 Wake Interference Analysis

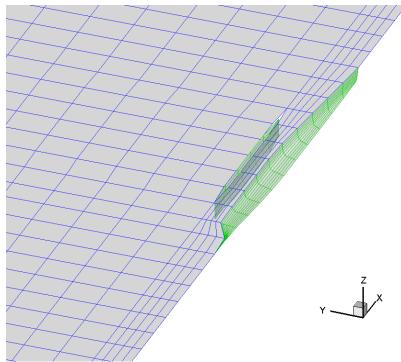


Figure 74. SWAN Hull Analysis Mesh Condition 1-3

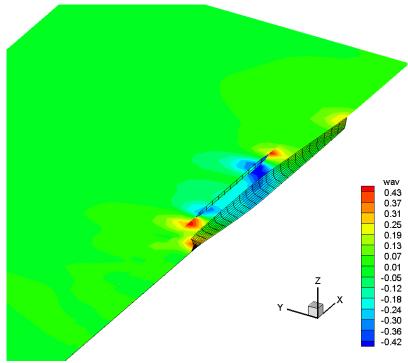


Figure 75. Condition 1-3 Wake interference at 15 kts

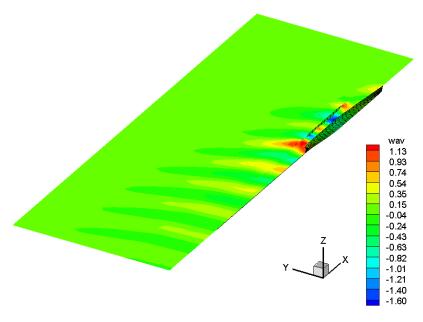


Figure 76. Condition 1-3 Wake interference at 20 kts

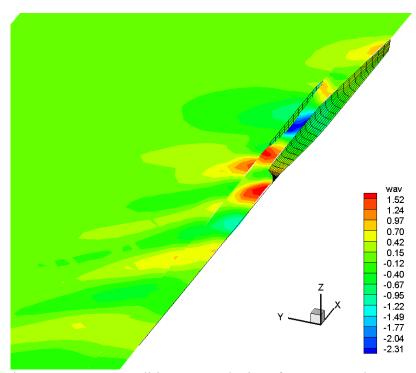


Figure 77. Condition 1-3 Wake interference at 25 kts

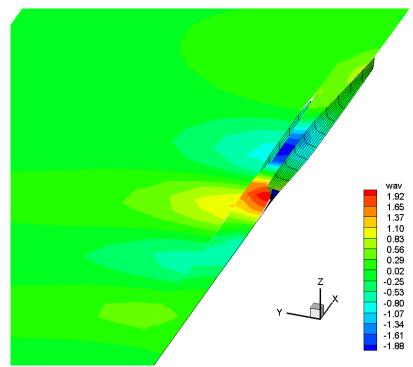


Figure 78. Condition 1-3 Wake interference at 30 kts

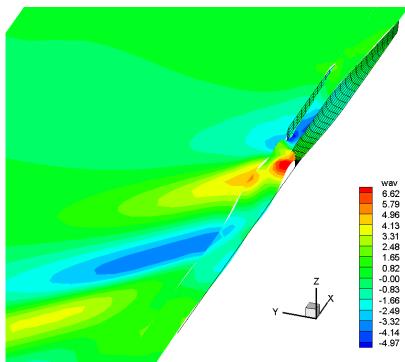


Figure 79. Condition 1-3 Wake interference at 35 kts

d. Condition 1-4 Wake Interference Analysis

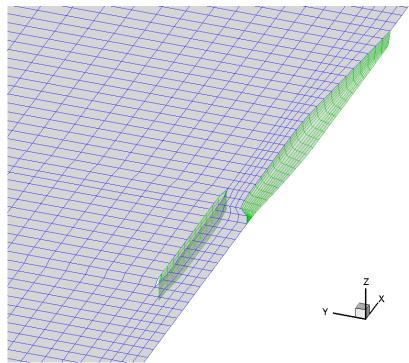


Figure 80. SWAN Hull Analysis Mesh Condition 1-4

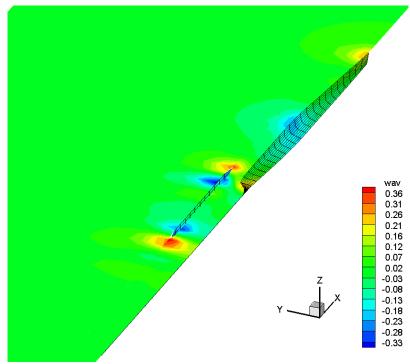


Figure 81. Condition 1-4 Wake interference at 15 kts

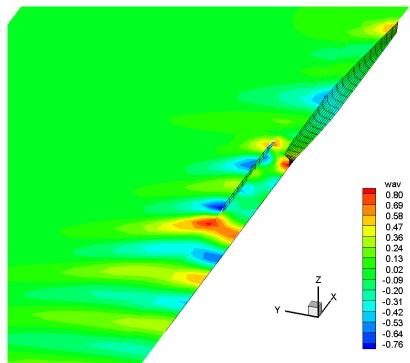


Figure 82. Condition 1-4 Wake interference at 20 kts

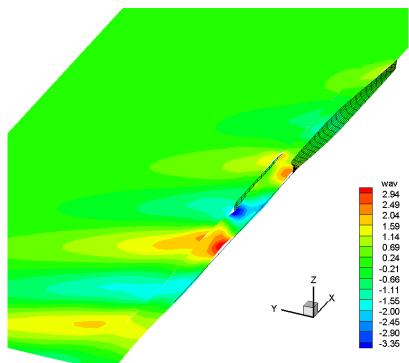


Figure 83. Condition 1-4 Wake interference at 25 kts

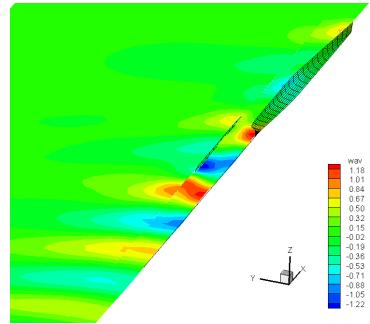


Figure 84. Condition 1-4 Wake Interference at 30 kts

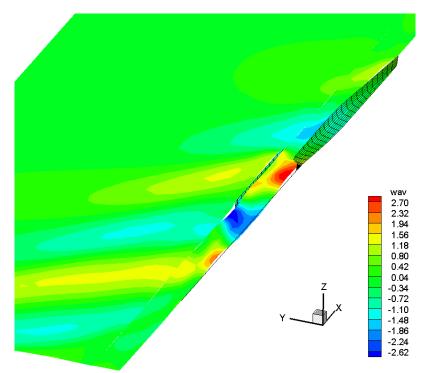


Figure 85. Condition 1-4 Wake interference at 35 kts.

e. Condition 1-5 Wake Interference Analysis

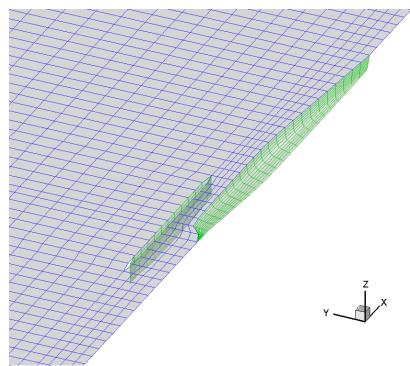


Figure 86. SWAN Hull Analysis Mesh Condition 1-5

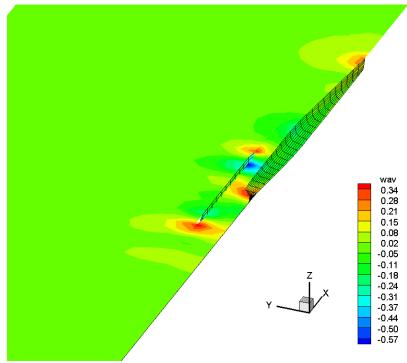


Figure 87. Condition 1-5 Wake interference at 15 kts

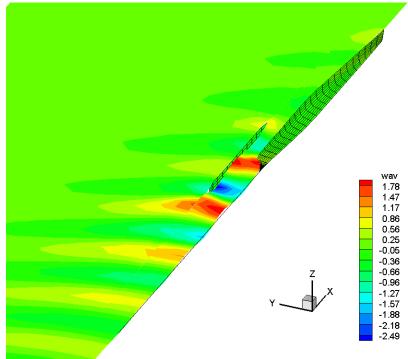


Figure 88. Condition 1-5 Wake interference at 20 kts

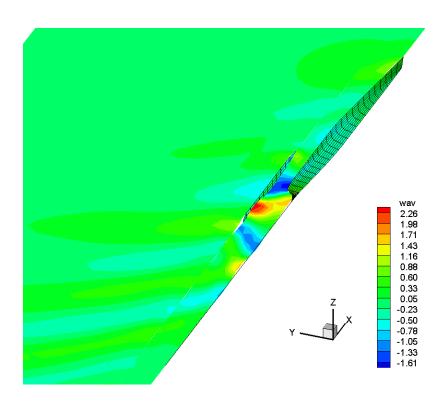


Figure 89. Condition 1-5 Wake interference at 25 kts

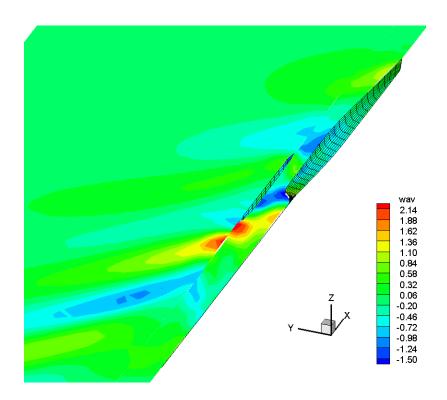


Figure 90. Condition 1-5 Wake interference at 30 kts

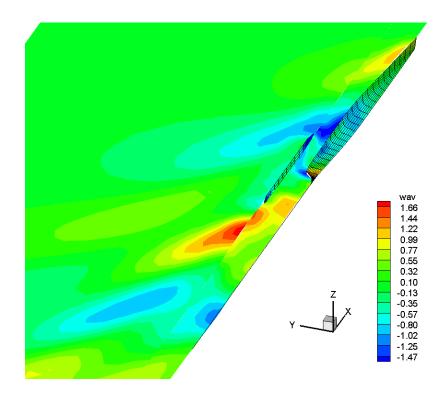


Figure 91. Condition 1-5 Wake interference at 35 kts

f. Condition 1-6 Wake Interference Analysis

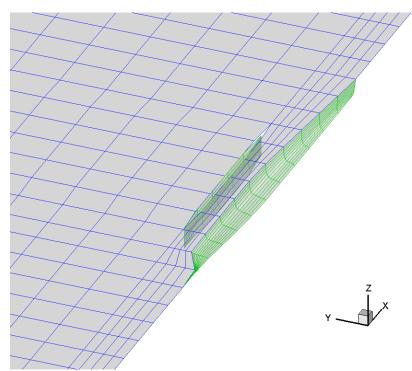


Figure 92. SWAN Hull Analysis Mesh Condition 1-6

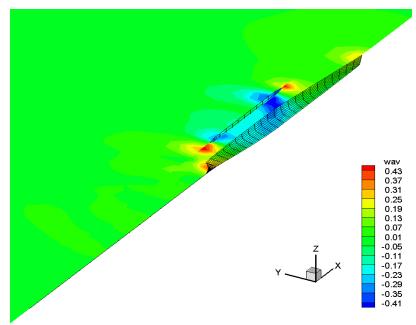


Figure 93. Condition 1-6 Wake interference at 15 kts

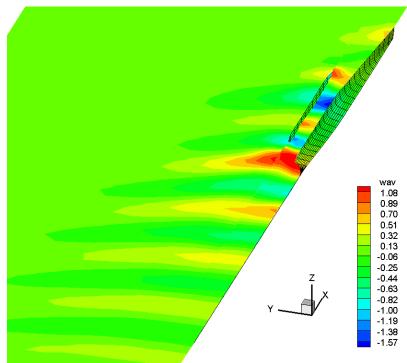


Figure 94. Condition 1-6 Wake interference at 20 kts

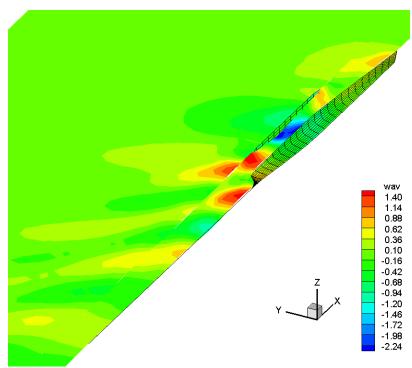


Figure 95. Condition 1-6 Wake interference at 25 kts

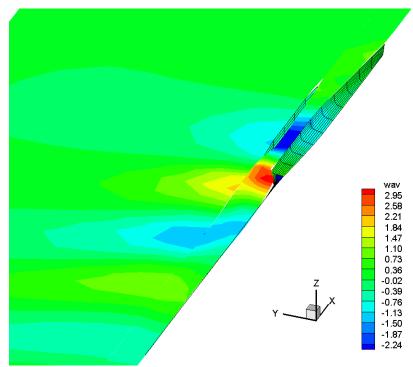


Figure 96. Condition 1-6 Wake interference at 30 kts

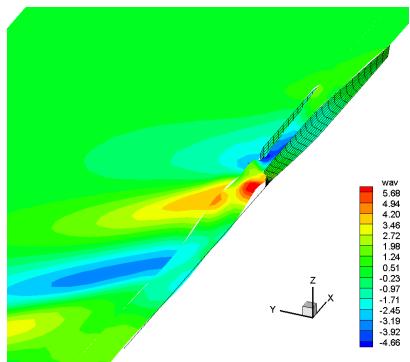


Figure 97. Condition 1-6 Wake interference at 35 kts

2. Tandem Strut Side Hulls

a. Condition 2-1 Wake Interference Analysis

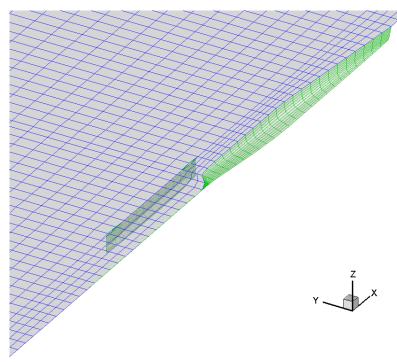


Figure 98. SWAN Hull Analysis Mesh Condition 2-1

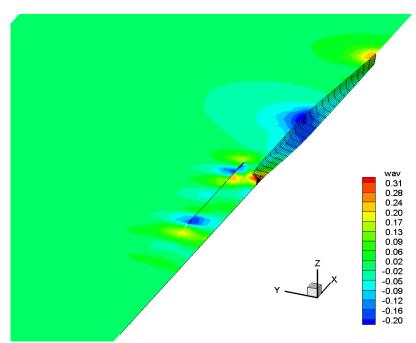


Figure 99. Condition 2-1 Wake interference at 15 kts

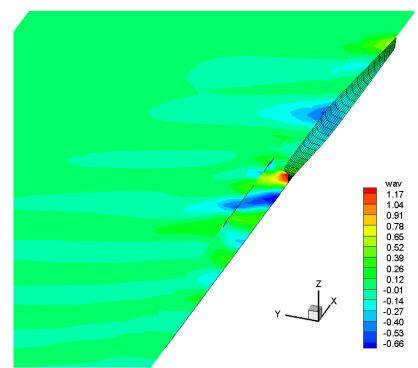


Figure 100. Condition 2-1 Wake interference at 20 kts

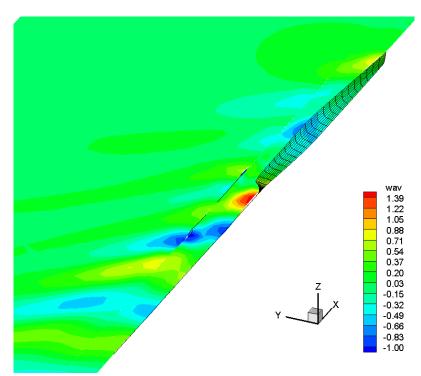


Figure 101. Condition 2-1 Wake interference at 25 kts

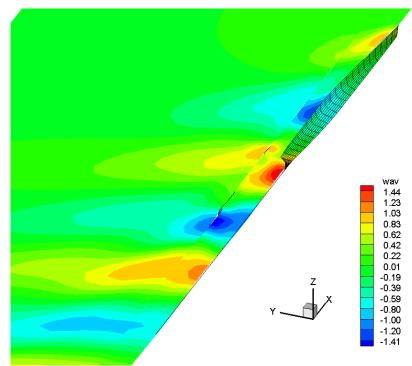


Figure 102. Condition 2-1 Wake interference at 30 kts

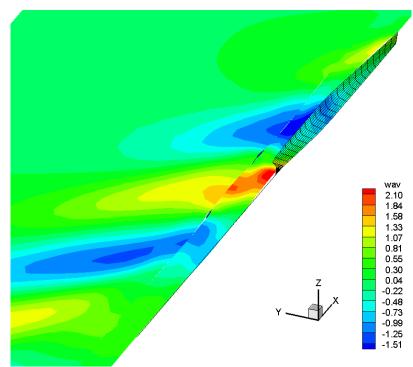


Figure 103. Condition 2-1 Wake interference at 35 kts

b. Condition 2-2 Wake Interference Analysis

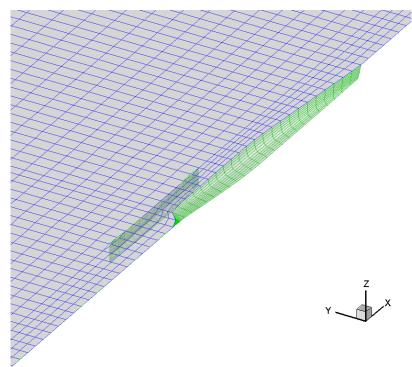


Figure 104. SWAN Hull Analysis Mesh Condition 2-2

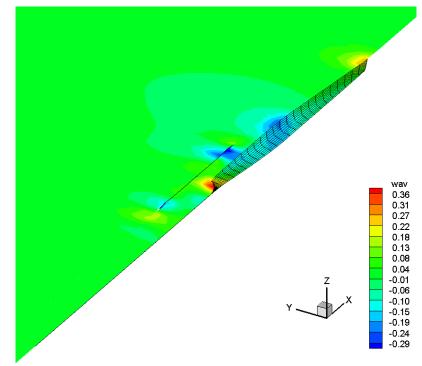


Figure 105. Condition 2-2 Wake interference at 15 kts

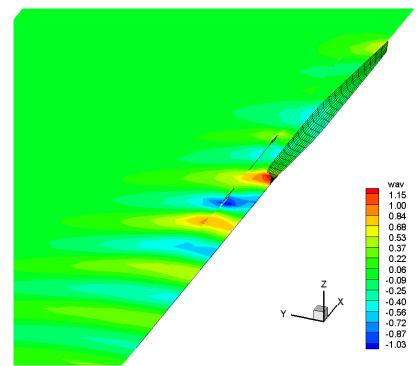


Figure 106. Condition 2-2 Wake interference at 20 kts

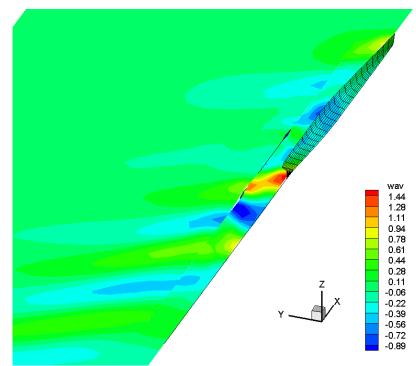


Figure 107. Condition 2-2 Wake interference at 25 kts

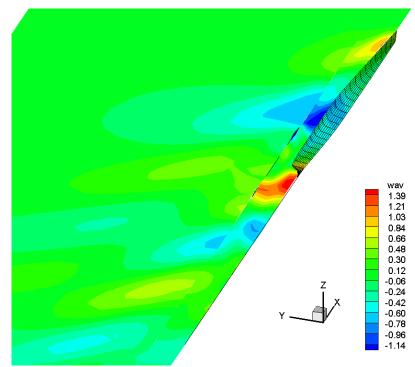


Figure 108. Condition 2-2 Wake interference at 30 kts

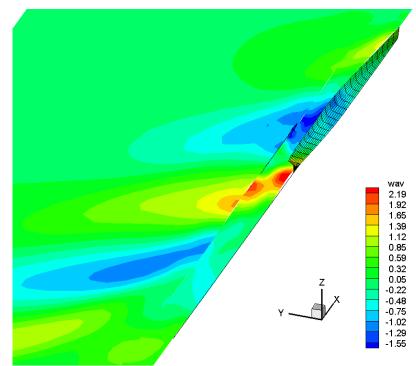


Figure 109. Condition 2-2 Wake interference at 35 kts

c. Condition 2-3 Wake Interference Analysis

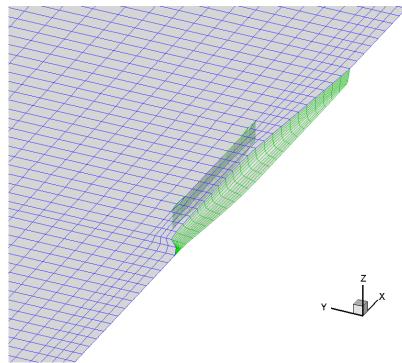


Figure 110. SWAN Hull Analysis Mesh Condition 2-3

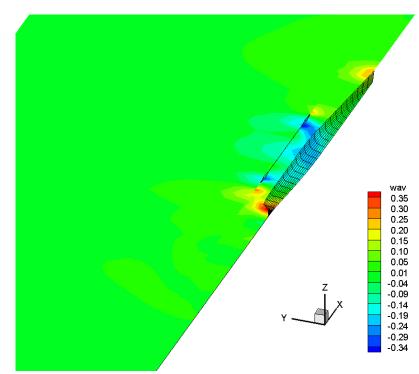


Figure 111. Condition 2-3 Wake interference at 15 kts

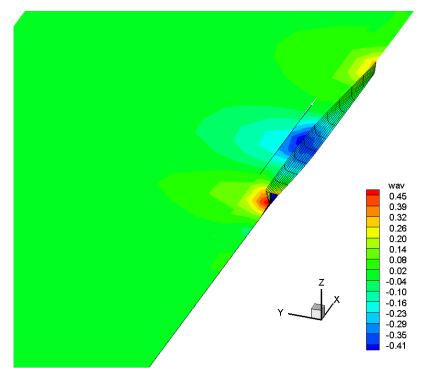


Figure 112. Condition 2-3 Wake interference at 20 kts

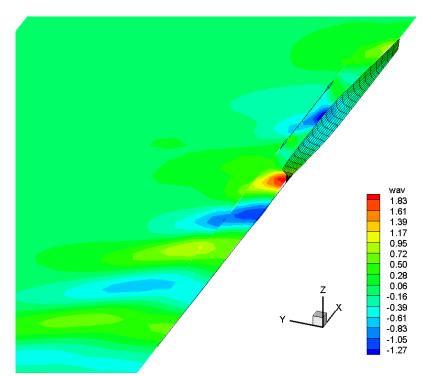


Figure 113. Condition 2-3 Wake interference at 25 kts

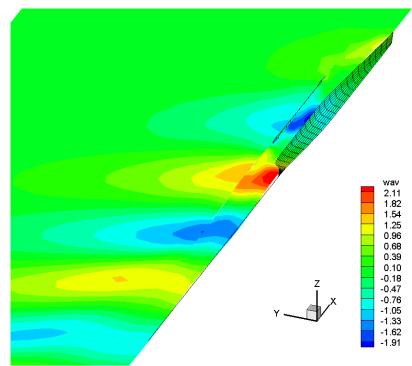


Figure 114. Condition 2-3 Wake interference at 30 kts

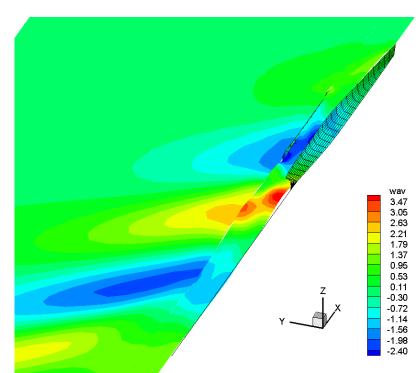


Figure 115. Condition 2-3 Wake interference at 35 kts

d. Condition 2-4 Wake Interference Analysis

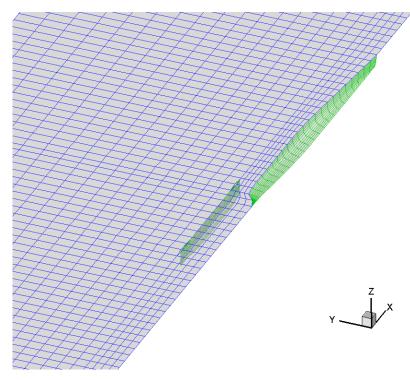


Figure 116. SWAN2 Hull Analysis Mesh Condition 2-4

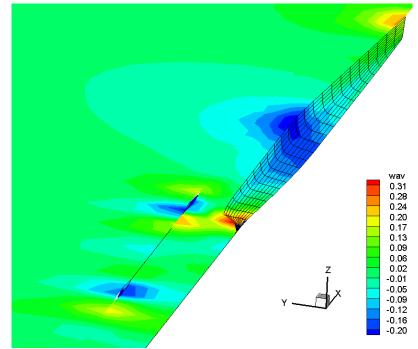


Figure 117. Condition 2-4 Wake Interference at 15 kts

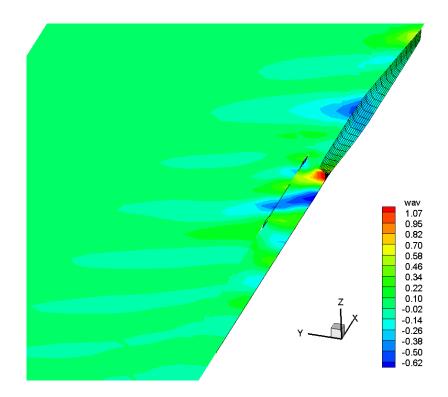


Figure 118. Condition 2-4 Wake Interference at 20 kts

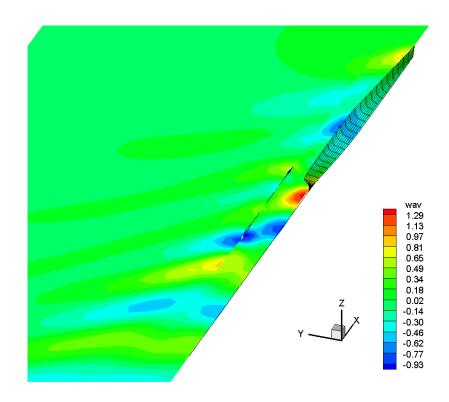


Figure 119. Condition 2-4 Wake Interference at 25 kts

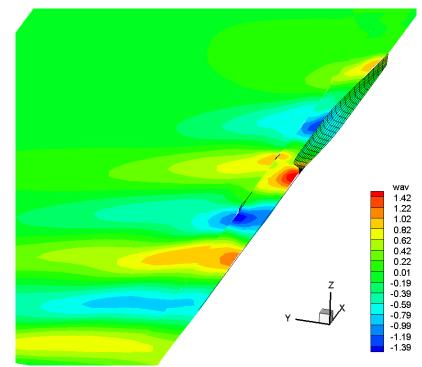


Figure 120. Condition 2-4 Wake Interference at 30 kts

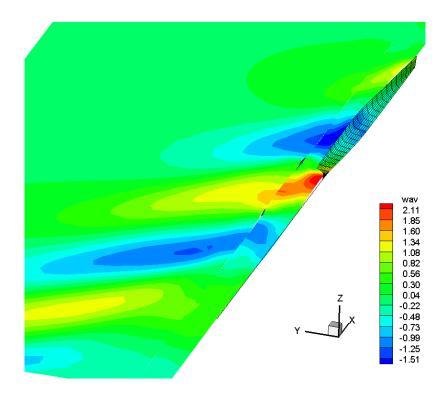


Figure 121. Condition 2-4 Wake Interference at 35 kts

e. Condition 2-5 Wake Interference Analysis

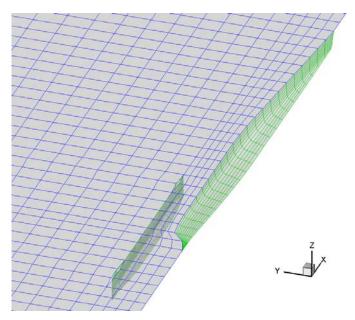


Figure 122. SWAN2 Hull Analysis Mesh Condition 2-5

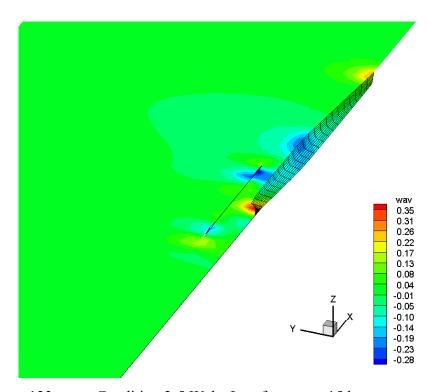


Figure 123. Condition 2-5 Wake Interference at 15 kts

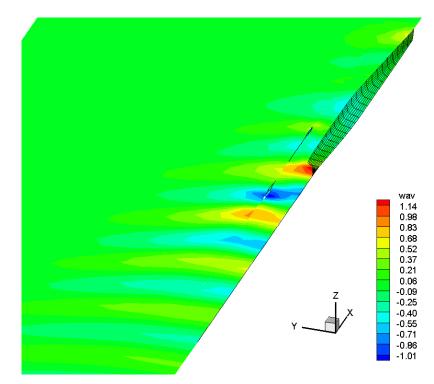


Figure 124. Condition 2-5 Wake Interference at 20 kts

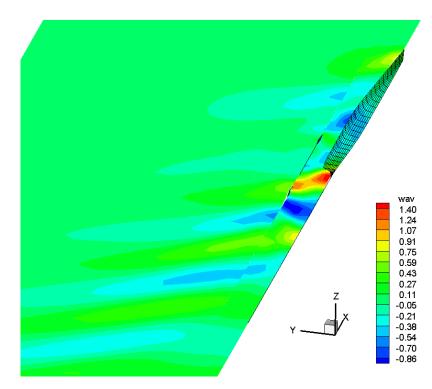


Figure 125. Condition 2-5 Wake Interference at 25 kts

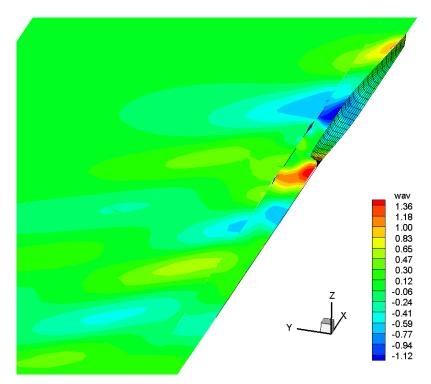


Figure 126. Condition 2-5 Wake Interference at 30 kts

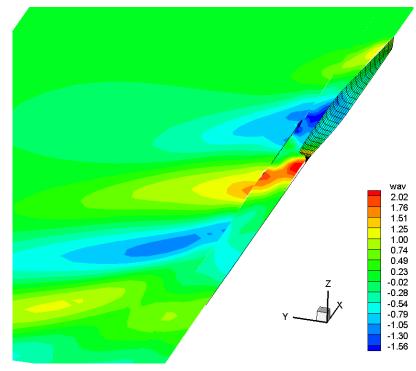


Figure 127. Condition 2-5 Wake Interference at 35 kts

f. Condition 2-6 Wake Interference Analysis

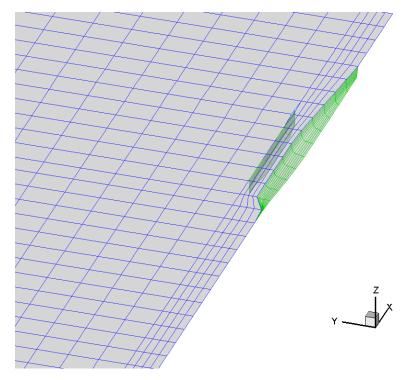
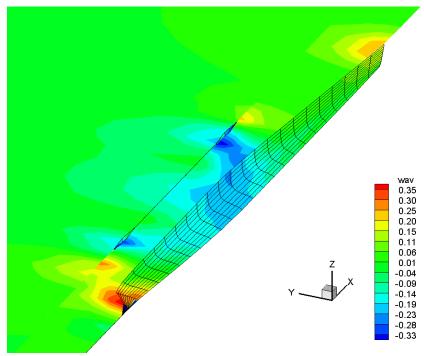


Figure 128. SWAN2 Hull Analysis Mesh Condition 2-6



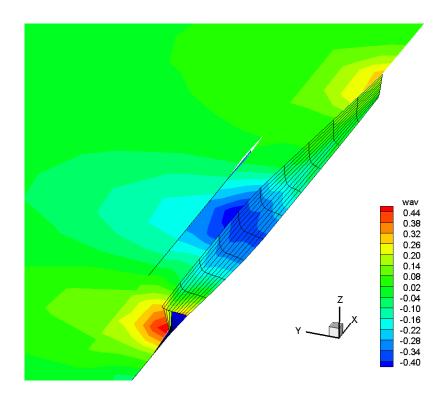


Figure 130. Condition 2-6 Wake Interference at 20 kts

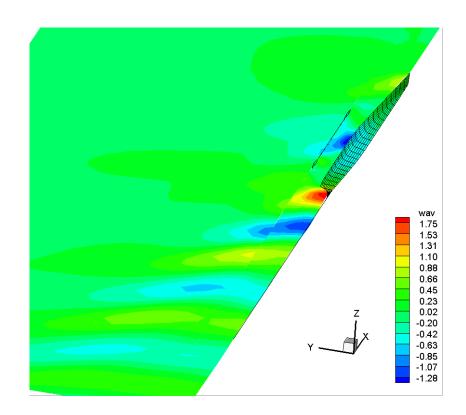


Figure 131. Condition 2-6 Wake Interference at 25 kts

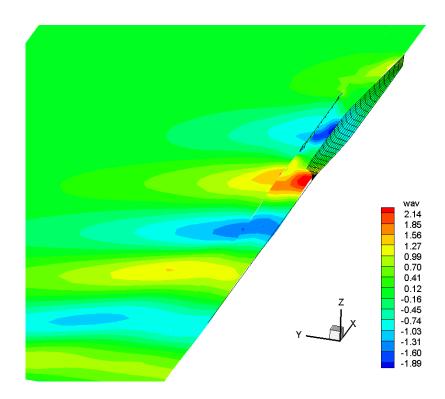


Figure 132. Condition 2-6 Wake Interference at 30 kts

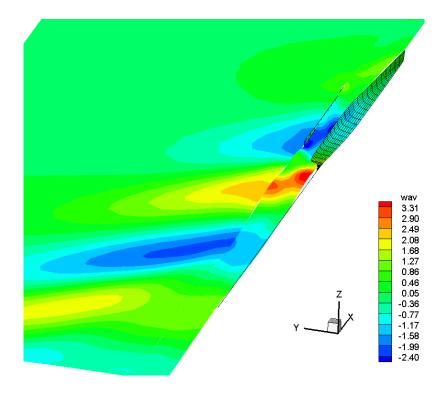


Figure 133. Condition 2-6 Wake Interference at 35 kts 100

3. Triple Inline Strut Side Hulls

a. Condition 3-1 Wake Interference Analysis

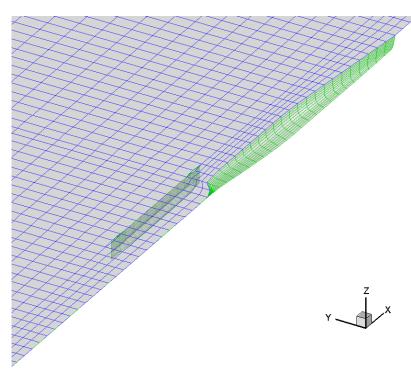


Figure 134. SWAN Hull Analysis Mesh Condition 3-1

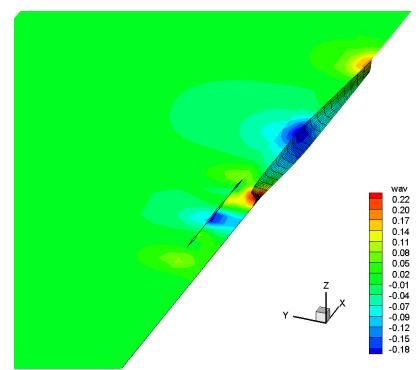


Figure 135. Condition 3-1 Wake Interference at 15 kts

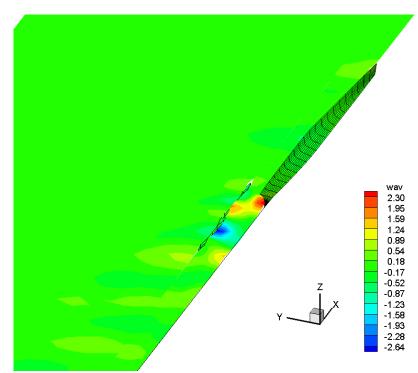


Figure 136. Condition 3-1 Wake Interference at 20 kts

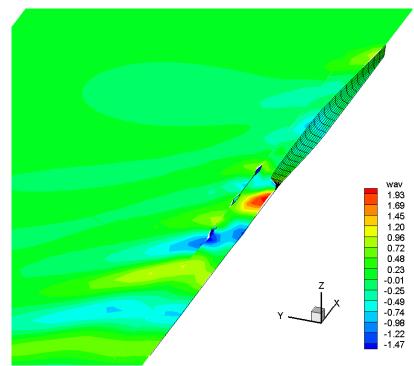


Figure 137. Condition 3-1 Wake Interference at 25 kts

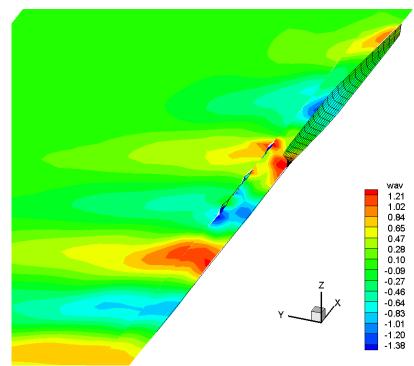


Figure 138. Condition 3-1 Wake Interference at 30 kts

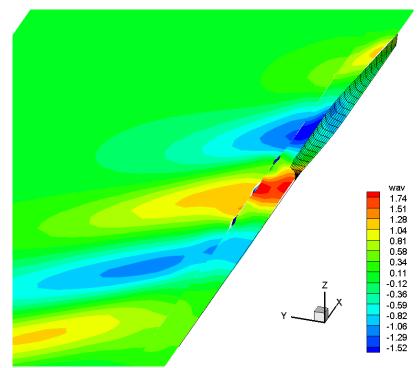


Figure 139. Condition 3-1 Wake Interference at 35 kts

b. Condition 3-2 Wake Interference Analysis

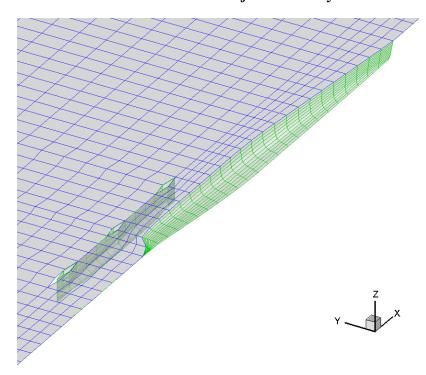


Figure 140. SWAN Hull Analysis Mesh Condition 3-2

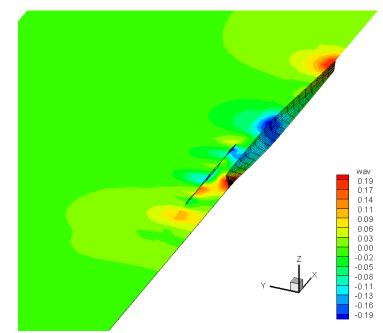


Figure 141. Condition 3-2 Wake Interference at 15 kts

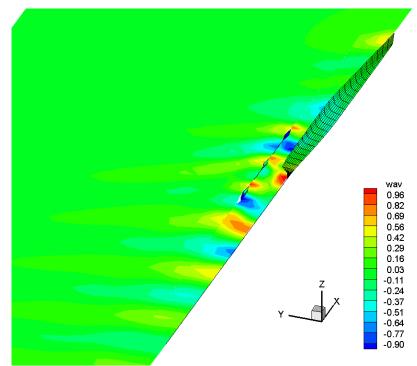


Figure 142. Condition 3-2 Wake Interference at 20 kts

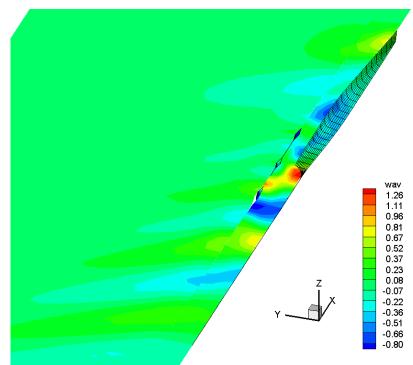


Figure 143. Condition 3-2 Wake Interference at 25 kts

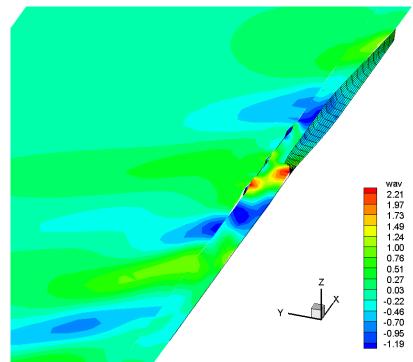


Figure 144. Condition 3-2 Wake Interference at 30 kts

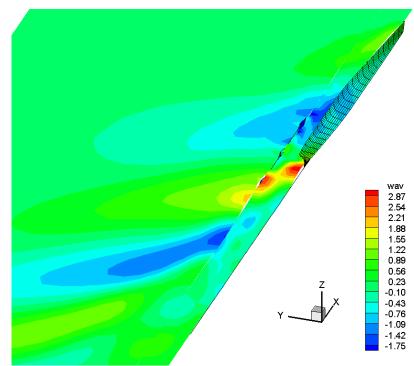


Figure 145. Condition 3-2 Wake Interference at 35 kts

c. Condition 3-3 Wake Interference Analysis

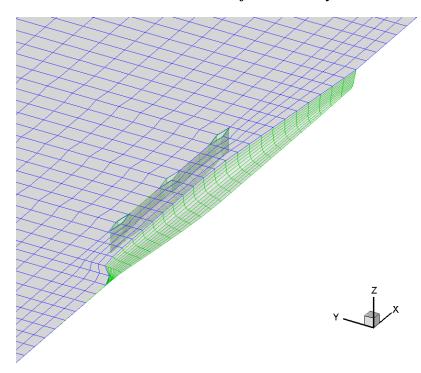


Figure 146. SWAN Hull Analysis Mesh Condition 3-3

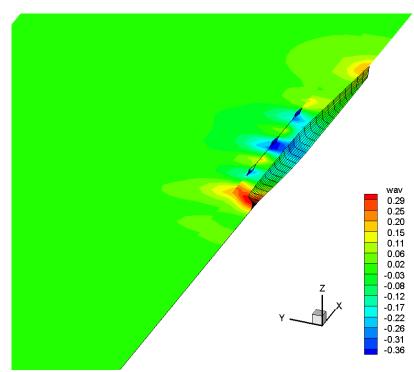


Figure 147. Condition 3-3 Wake Interference at 15 kts

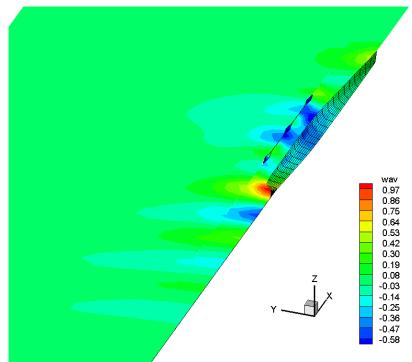


Figure 148. Condition 3-3 Wake Interference at 20 kts

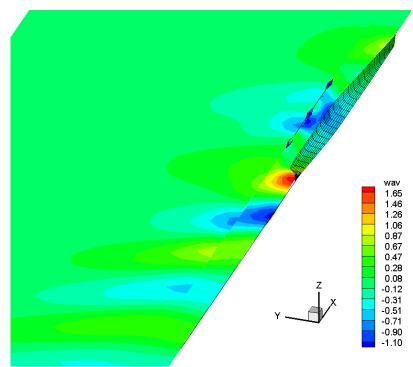


Figure 149. Condition 3-3 Wake Interference at 25 kts

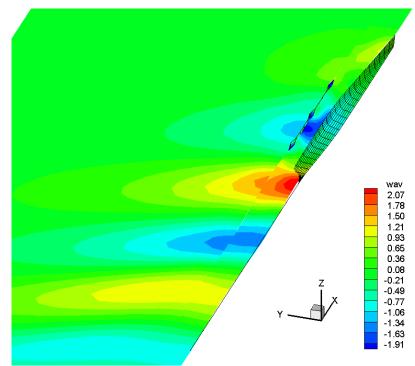


Figure 150. Condition 3-3 Wake Interference at 30 kts

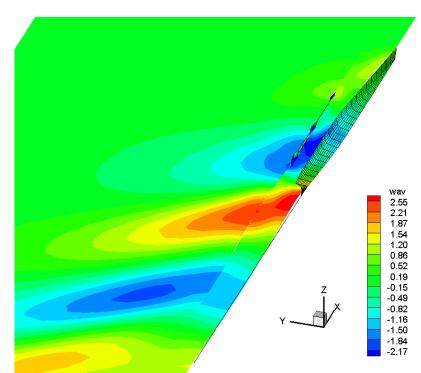


Figure 151. Condition 3-3 Wake Interference at 35 kts

d. Condition 3-4 Wake Interference Analysis

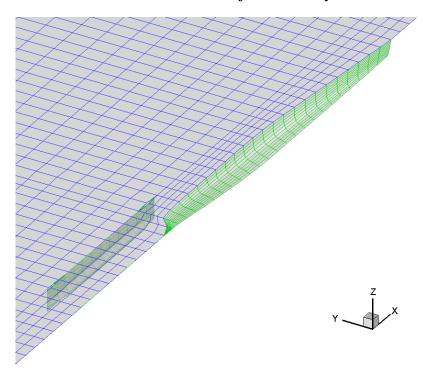


Figure 152. SWAN Hull Analysis Mesh Condition 3-4

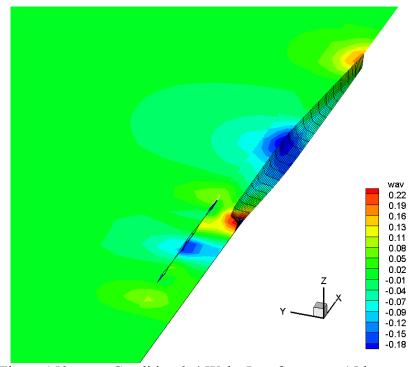


Figure 153. Condition 3-4 Wake Interference at 15 kts

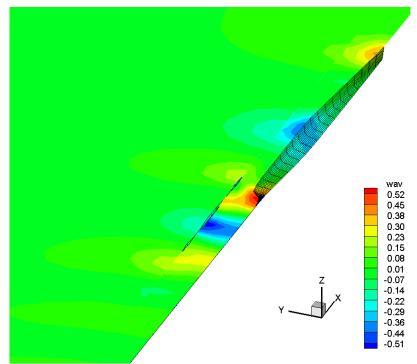


Figure 154. Condition 3-4 Wake Interference at 20 kts

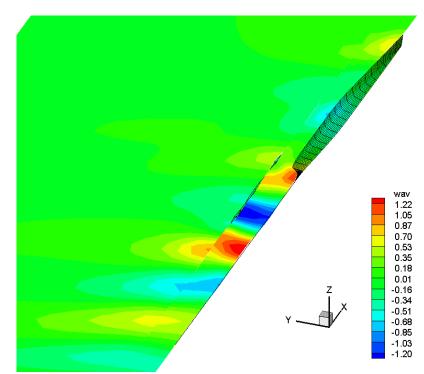


Figure 155. Condition 3-4 Wake Interference at 25 kts

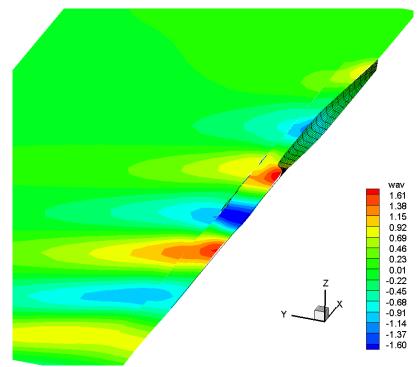


Figure 156. Condition 3-4 Wake Interference at 30 kts

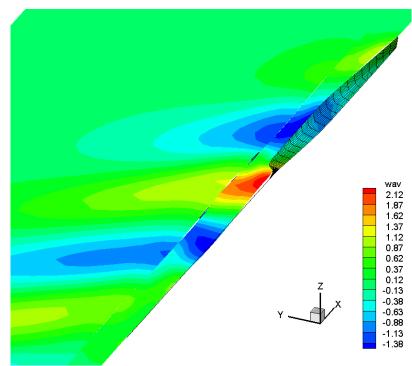


Figure 157. Condition 3-4 Wake Interference at 35 kts

e. Condition 3-5 Wake Interference Analysis

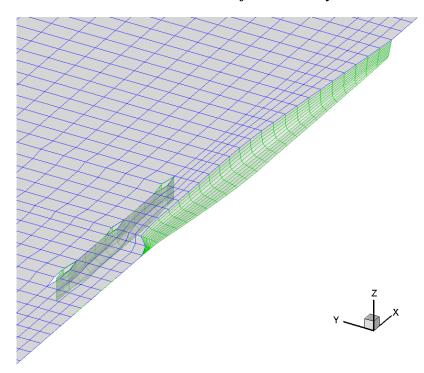


Figure 158. SWAN Hull Analysis Mesh Condition 3-5

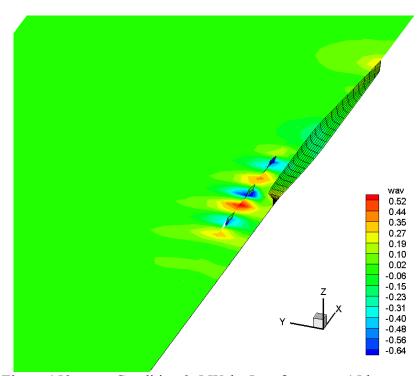


Figure 159. Condition 3-5 Wake Interference at 15 kts

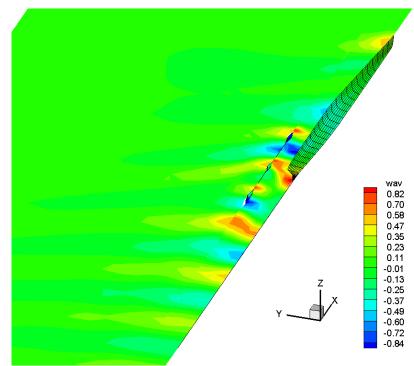


Figure 160. Condition 3-5 Wake Interference at 20 kts

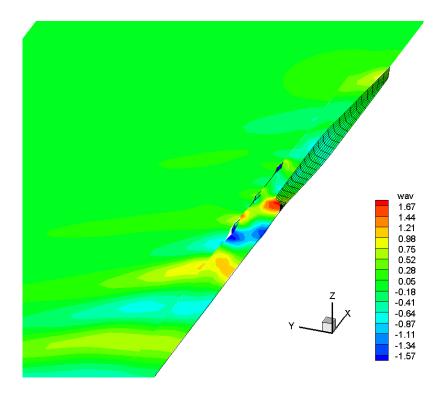


Figure 161. Condition 3-5 Wake Interference at 25 kts

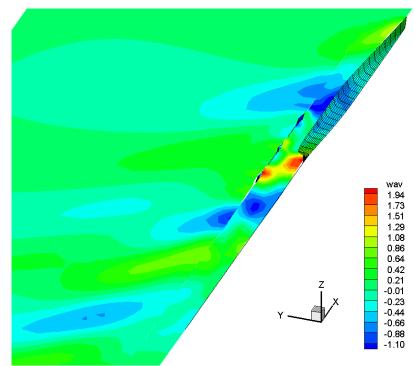


Figure 162. Condition 3-5 Wake Interference at 30 kts

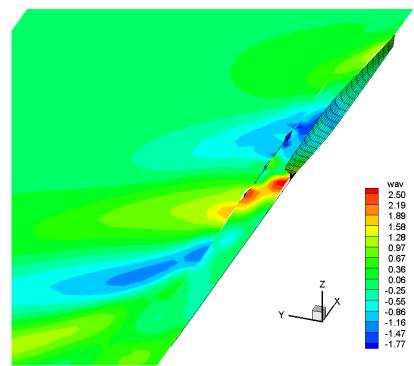


Figure 163. Condition 3-5 Wake Interference at 35 kts

f. Condition 3-6 Wake Interference Analysis

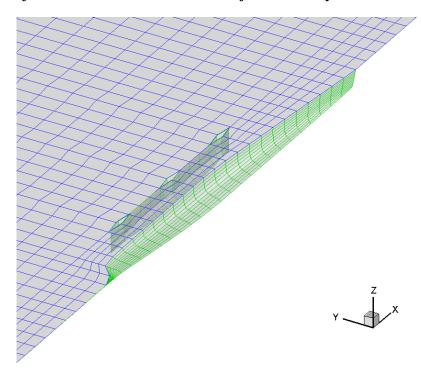


Figure 164. SWAN Hull Analysis Mesh Condition 3-6

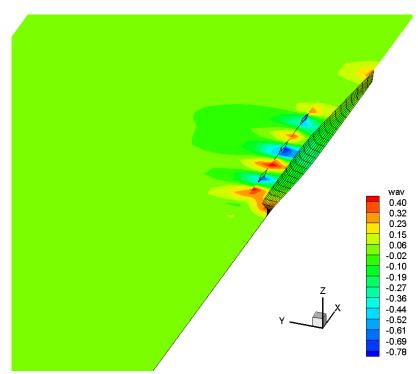


Figure 165. Condition 3-6 Wake Interference at 15 kts

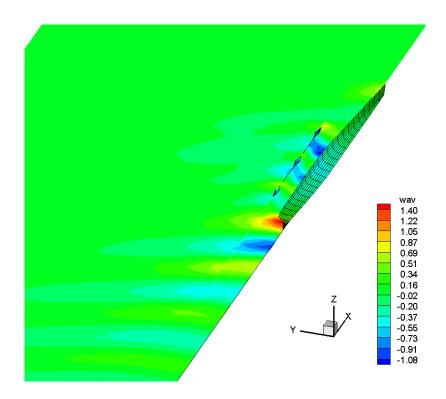


Figure 166. Condition 3-6 Wake Interference at 20 kts

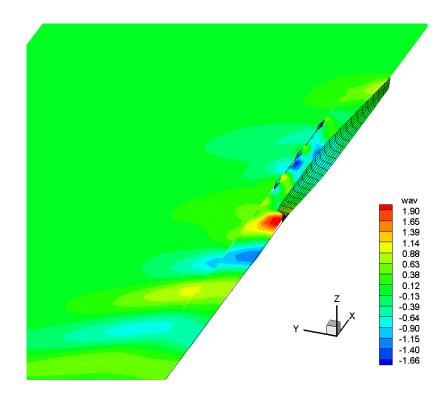


Figure 167. Condition 3-6 Wake Interference at 25 kts

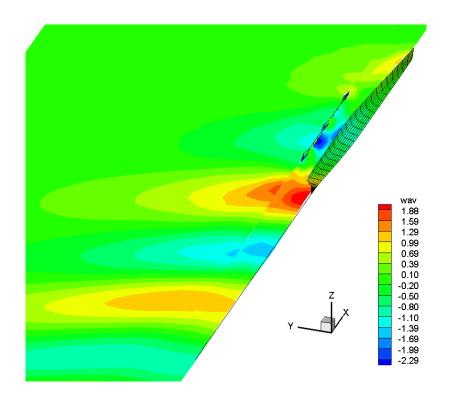


Figure 168. Condition 3-6 Wake Interference at 30 kts

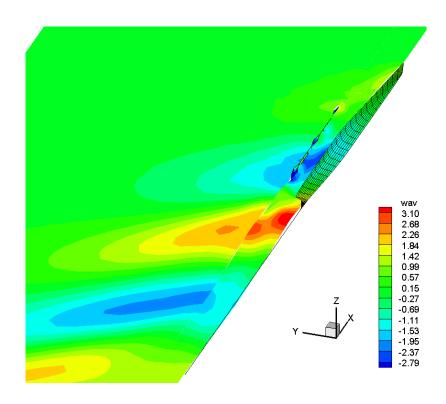


Figure 169. Condition 3-6 Wake Interference at 35 kts

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VIII. STATIC STABILITY

A. INTACT STATIC STABILITY

It is important to recognize that these ship configurations are being considered to meet the mission requirements set by the concept designs by enhancing the dynamic response from wave action developed by the interaction of the multiple hulls. In order to validate the models used in this research, fundamental comparison of basic ship characteristics needs to be completed. The ship configuration must be proven to simply stay upright in various conditions of gravitational stability and trim. Any design can prove to be disastrous if the naval architect overlooks these fundamental requirements. It is important to recognize that the ships that are under consideration are designed in such a way to accommodate the positioning of internal components in the side hulls, such as propulsion motors or engines, to lower the center of gravity at or near as possible to the keel of the center hull.

1. Center of Buoyancy

The center of Buoyancy is the location where the resultant force of buoyancy, equal to the weight of the displaced fluid, acts vertically through the vessel. It is also known to be the center of gravity of the combined volume of the displaced fluid. For this analysis, the center of buoyancy is a composition of the three hulls that make up the combined ship. Unlike a standard trimaran, one third of the ship's buoyancy is generated within the submerged side hulls. This makes for a more complicated determination of the centers.

In order to accurately calculate the center of buoyancy, all portions of the vessel below the waterline are included in the molded displacement curve. For a standard trimaran, the baseline of the center hull of the ship is the base line for the entire ship [6]. For the small waterplane slender trimaran, the side hulls extend deeper than the center hull and contain one-third of the displacement. To set the baseline of the ship at the center hull baseline would be insufficient for the calculation of the molded displacement of the entire ship. This problem may be resolved through two methods; either calculate

each hull and superposition each result through parallel axis theorem, or initially lump together the volumes of each hull subtracting volume of water between each hull.

The volumetric calculations for all eighteen hulls were completed using the Rhino Marine hydrostatic calculation software. The Rhino Marine calculations integrates the enclose areas of each hull at user selected waterline heights. The lateral separation of the side hulls does not change the section are curve.

Sectional Area Curve 1400 1200 1000 800 Area (feet^2) 600 400 200 -600 -500 -400 -300 -200 -100 100 200 300 Longitudinal Location (feet)

Figure 170. Section Area Chart for Condition 1-1, Condition 1-4

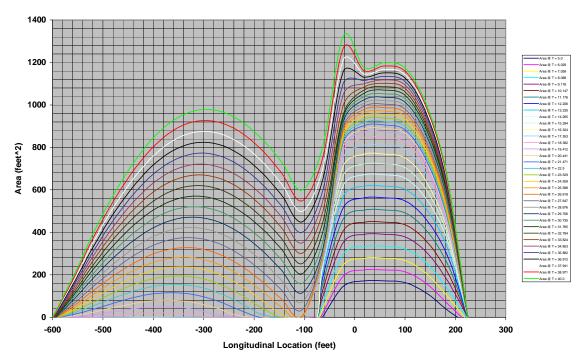


Figure 171. Section Area Chart for Condition 1-2, Condition 1-5

Sectional Area Curve

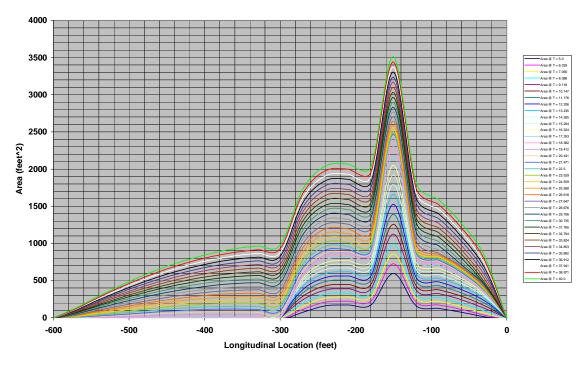


Figure 172. Section Area Chart for Condition 1-3, Condition 1-6

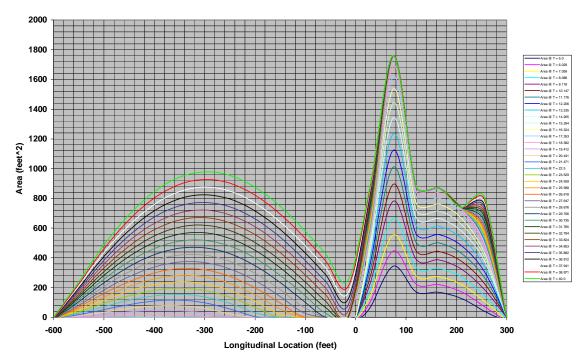


Figure 173. Section Area Chart for Condition 2-1, Condition 2-4

Sectional Area Curve

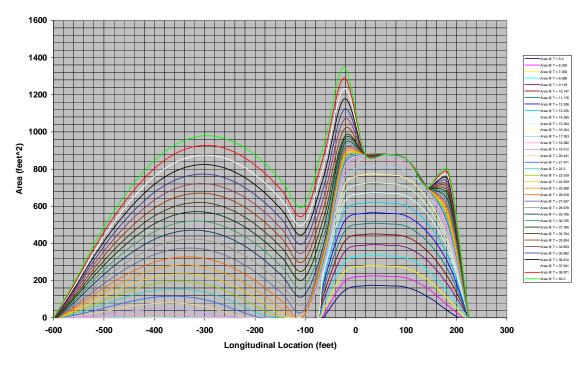


Figure 174. Section Area Chart for Condition 2-2, Condition 2-5

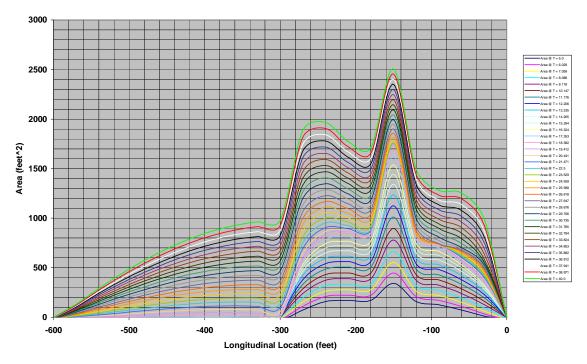


Figure 175. Section Area Chart for Condition 2-3, Condition 2-6

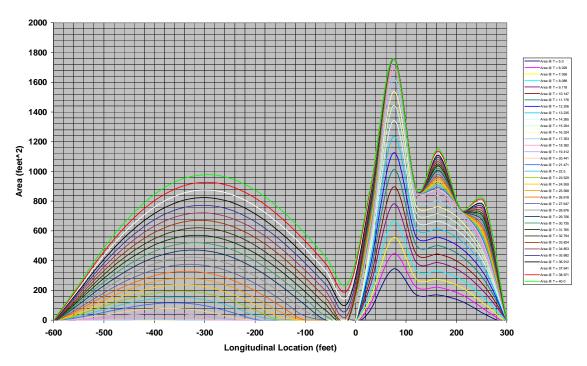


Figure 176. Section Area Chart for Condition 3-1, Condition 3-4 125

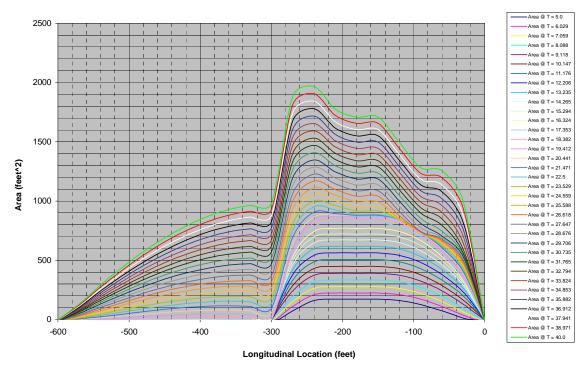


Figure 177. Section Area Chart for Condition 3-2, Condition 3-5

Sectional Area Curve

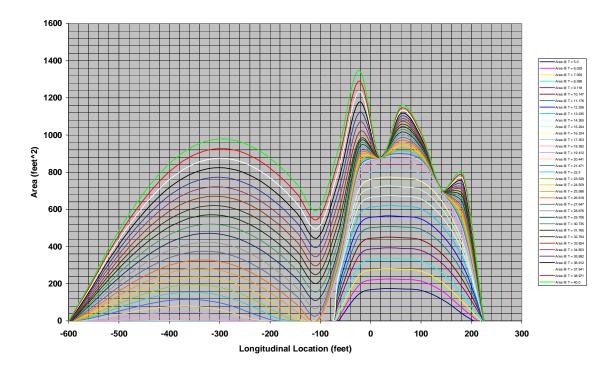


Figure 178. Section Area Chart for Condition 3-3, Condition 3-6 126

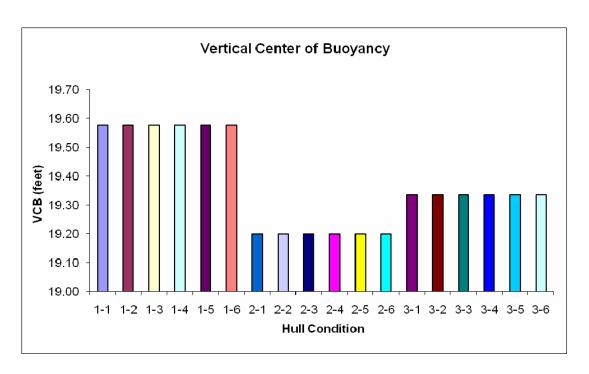


Figure 179. Vertical Center of Buoyancy (KB)

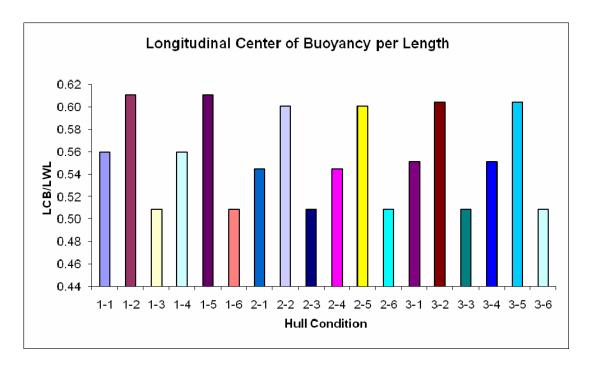


Figure 180. Longitudinal Center of Buoyancy per unit Length

2. Metacentric Height

When we consider a ship that is heeled to a very small angle, the center of buoyancy will move off the centerline. The line in which the center of gravity and the line in which center of buoyancy act, are offset by a line GZ [22], [23]. The line GZ is what is considered to be the righting arm of the ship. To find GZ we must first find the Metacentric radius BM. Transverse BM is the transverse moment if inertia of the waterplane divided by the displacement volume of the hull [22].

$$BM = \frac{I_T}{\nabla} \tag{1.23}$$

The moment of inertia I_T about the waterline of the ship reference from the aft perpendicular is given through the following equation [15];

$$I_T = \frac{2}{3} \int_{0}^{L} y^3 dx \tag{1.24}$$

Since each hull design is dealing with multiple separate bodies combined into one ship, parallel axis theorem must be implemented for all calculations to determine the moment of inertia for the entire ship. The area and inertia integrations may be performed using either Simpson's Rule or any available CAD software with analysis features. The following data is generated from RHINOMARINE analysis features.

Table 5. Component Moment of Inertia

Se	ection	Equation	Inertia	I_x
Cen	ter Hull	1.25	6.361×10^6	6.361×10^6
Stru	t (300ft)	1.26	7.53982×10^3	7.9715×10^6
Stru	ıt (60ft)	1.26	1.50796×10^3	2.24107×10^4

Table 6. Ship Moment of Inertia, Metacentric Height

	Y-posit	Volume	I_x	BM
1 Strut	64	666458.03	1.7258×10^7	25.90
1 Strut	55	666458.03	1.3628×10^7	20.45
2 Strut	64	624263.29	9.9467×10^6	15.93
2 Strut	55	624263.31	8.0774×10^6	12.94
3 Strut	64	639416.37	1.2292×10^7	19.22
3 Strut	55	639416.38	1.0038×10^7	15.70

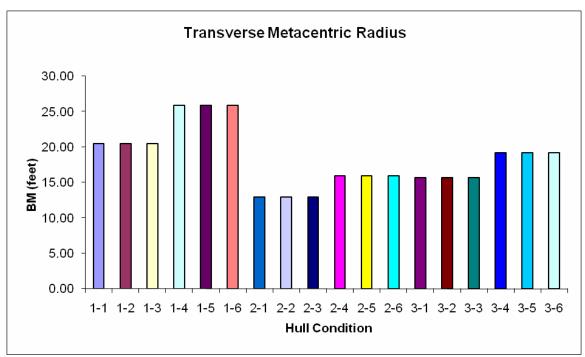


Figure 181. Transverse Metacentric Radius (BM)

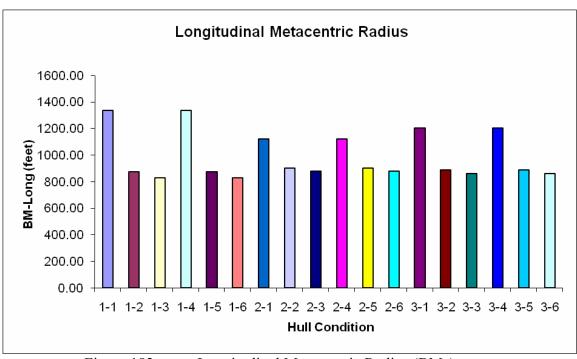


Figure 182. Longitudinal Metacentric Radius (BM_L)

From the Metacentric radius and the vertical center of buoyancy we get the Metacentric height above the keel with the following equation [22].

$$KM = KB + BM \tag{1.25}$$

By knowing the KM at any draft gives the designer of the ship system guidance as to how one can arrange the internal components of the ship to keep its center of gravity below to metacenter. We can see that the SWATH side hulls actually provide very little advantage to static stability. However, this is no surprise and the fact of the matter is that the SWATH design is advantageous for dynamic stability and resistance. Due to time constraints, how advantageous this design is to dynamic stability will have to be left for further research.

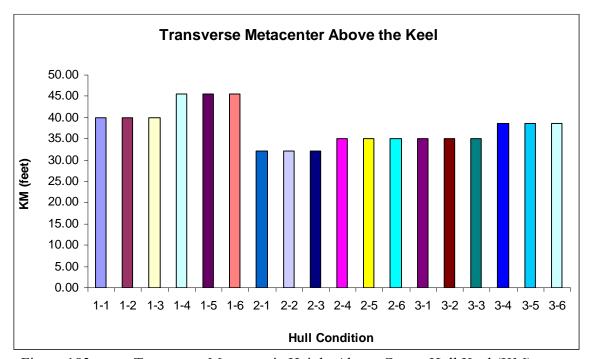


Figure 183. Transverse Metacentric Height Above Center Hull Keel (KM)

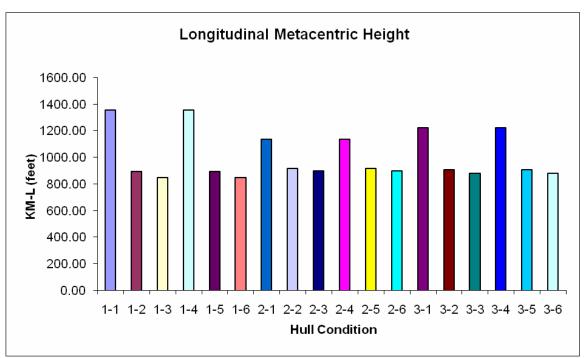


Figure 184. Longitudinal Metacentric Height Above Keel (KM_L)

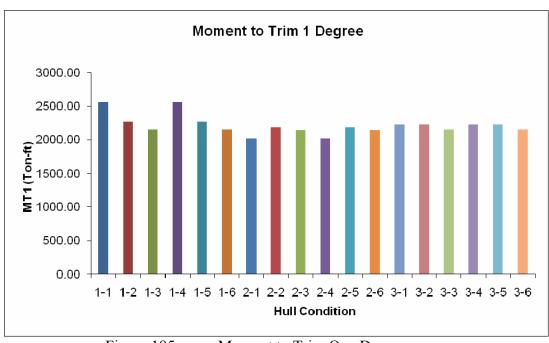


Figure 185. Moment to Trim One Degree

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IX. ANALYSIS OF ALTERNATIVES

A. DISCUSSION

In the previous sections, the application of engineering and mathematical resources were used to develop system performance parameters and suitable system configurations to be used in an iterative process of definition, synthesis, analysis, test, and evaluation in order to optimize a total functional systems design. The final phase of this report combines the results of the various hull configuration analyses through a systems engineering approach of weighted attributes. Each performance parameter is normalized and multiplied by an subjective weighting factor which is based on the assumed importance of the parameter.

1. Weighting Factor Selection

The weighting factor for each parameter have been selected based on a direct ranking analysis of alternatives method and by determining relative importance of each.

a. Resistance

A weighting factor of 0.25 was assigned to average resistance. This was selected based on the high importance of determining a vessel that has wide range of efficient operation. A weighting factor 0.25 was assigned to maximum resistance. This factor was selected to highlight the importance of efficiency at high speeds and its equivalence to overall resistance. All resistance data points are normalized to the maximum value of the respective resistance sample data for all configurations.

b. Stability

A weighting factor of 0.05 was assigned to BM and a factor of 0.2 for KM since the center hull of the ship was selected based on known monohull designs and is a significantly sensitive parameter for the small water plane area trimaran designs. It is necessary to normalize the values of BM and KM to the minimum of all the sample data since the naval architect's desired value is the greatest value of BM and KM.

c. Wake Interference

A weighting factor of 0.15 is assigned to the maximum wake height experienced at 15 knots. The importance of this selection is based on the requirement to operate in congested areas, harbors, and ports near smaller vessels. A weighting factor of 0.1 is assigned to the maximum wake height experienced at 35 knots. This factor was selected based on the importance of maintaining a reasonable wake height at the vessel's maximum speed to minimize radiated wave generation far away from the vessel.

B. ALTERNATIVES MATRIX

The table below shows the analysis of alternatives matrix and the ranking based on the calculated results. The lowest total calculation is the optimal design configuration.

AvgResistance MaxResistance BM KM Wake@ 15kts Wake @ 35kts Total 0.25 0.15 0.25 0.050.20.1Condition 3-2 0.051 0.013 0.052 0.013 0.05603 0.00280 0.011158 0.0046 0.00550 0.04997 0.05579 0.031 0.055 Condition 3-1 0.055 0.014 0.014 0.00280 0.011158 0.0054 0.055 0.05603 0.05579 0.036 0.033 0.00333 0.04998 Condition 3-4 0.055 0.014 0.055 0.014 0.05540 0.00277 0.05548 0.011097 0.036 0.0054 0.041 0.00406 0.05071 Condition 3-3 0.014 0.013 0.055 0.011158 0.05302 0.054 0.05603 0.00280 0.05579 0.047 0.0071 0.049 0.00488 Condition 2-4 0.055 0.014 0.057 0.011156 0.050 0.00404 0.05353 0.014 0.05599 0.00280 0.05578 0.0076 0.040 Condition 2-1 0.055 0.014 0.057 0.014 0.05652 0.00283 0.05604 0.011208 0.050 0.0076 0.040 0.00402 0.05357 Condition 1-5 0.060 0.015 0.056 0.014 0.05421 0.00271 0.05488 0.010977 0.055 0.0083 0.00318 0.05417 0.032 Condition 2-5 0.056 0.014 0.056 0.014 0.05599 0.00280 0.05578 0.011156 0.057 0.0085 0.039 0.00387 0.05440 Condition 2-2 0.056 0.014 0.056 0.014 0.05652 0.00283 0.011208 0.059 0.0088 0.00419 0.05496 0.05604 Condition 1-4 0.056 0.014 0.056 0.014 0.05421 0.00271 0.05488 0.010977 0.059 0.0088 0.00517 0.05579 Condition 1-2 0.015 0.015 0.011071 0.00450 0.058 0.05518 0.00276 0.0085 0.05631 Condition 2-6 0.057 0.014 0.055 0.014 0.05599 0.00280 0.05578 0.011156 0.057 0.0085 0.063 0.00634 0.05677 Condition 2-3 0.014 0.054 0.014 0.011208 0.00664 0.05697 0.057 0.05652 0.00283 0.05604 0.057 0.0085 0.066 Condition 3-5 0.011097 0.051 0.013 0.052 0.013 0.05540 0.00277 0.05548 0.085 0.0127 0.048 0.00479 0.05712 Condition 3-6 0.056 0.014 0.014 0.05540 0.05548 0.011097 0.065 0.0098 0.05714 0.054 0.00277 0.059 0.00594 Condition 1-1 0.057 0.014 0.059 0.015 0.05518 0.00276 0.05536 0.011071 0.060 0.0090 0.060 0.00599 0.05790 Condition 1-6 0.056 0.014 0.058 0.014 0.05421 0.00271 0.05488 0.010977 0.070 0.0105 0.109 0.01088 0.06346 Condition 1-3 0.013 0.014 0.05518 0.00276 0.05536 0.011071 0.070 0.0105 0.127 0.054 0.055 0.01268

Table 7. Analysis of Alternatives Matrix

From the normalized values for the Metacentric Height and the normalized values of the coefficient of resistance for each simulation speed, the following characteristic plots present the Pareto front where the maximum KM with the lowest Coefficient of Resistance can be easily determined. The plots show that there is no one configuration that stands out as the optimal hull for all speeds based on coefficient of resistance alone.

Total Resistance at 15 knots vs. KM

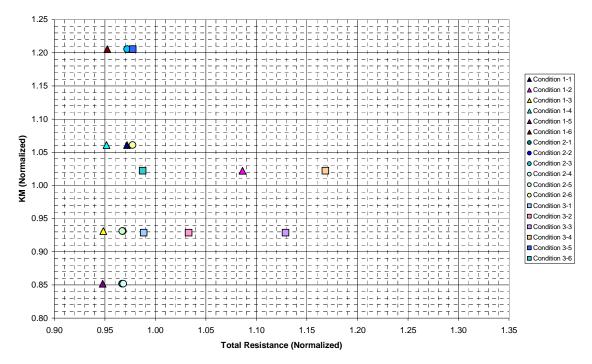


Figure 186. Normalized Total Resistance at 15 knots vs. KM

Total Resistance at 20 knots vs. KM

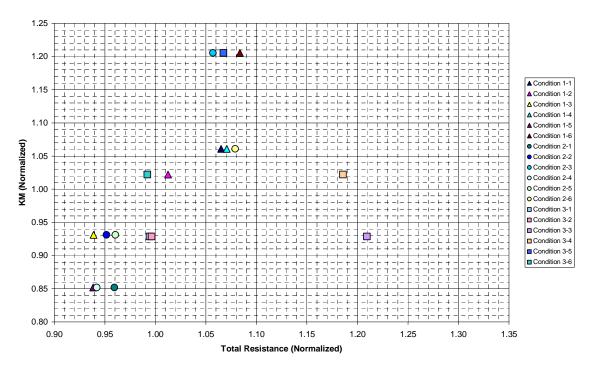


Figure 187. Normalized Total Resistance at 20 knots vs. KM

Total Resistance at 25 knots vs. KM

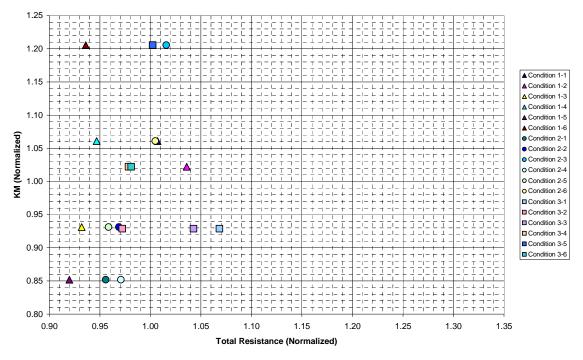


Figure 188. Normalized Total Resistance at 25 knots vs. KM

Total Resistance at 30 knots vs. KM

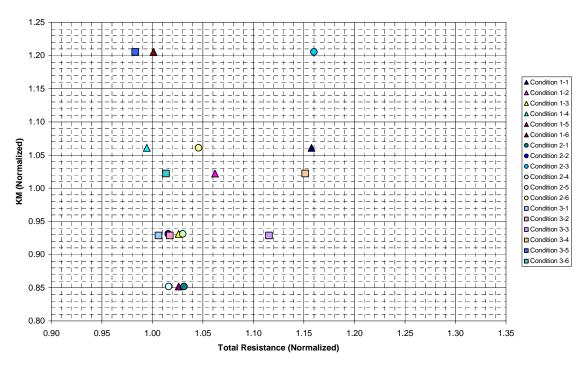


Figure 189. Normalized Total Resistance at 30 knots vs. KM 136

Total Resistance at 35 knots vs. KM

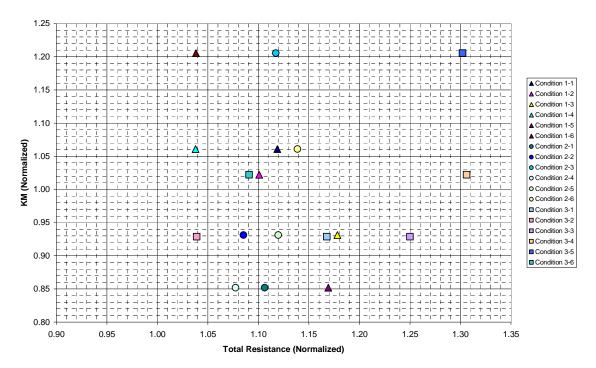


Figure 190. Normalized Total Resistance at 35 knots vs. KM

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X. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

From the analysis of alternatives and the performance parameters generated by the computational studies the Condition 3-2 hull arrangement is the optimal design for resistance and static stability for a Small Waterplane Area Trimaran.

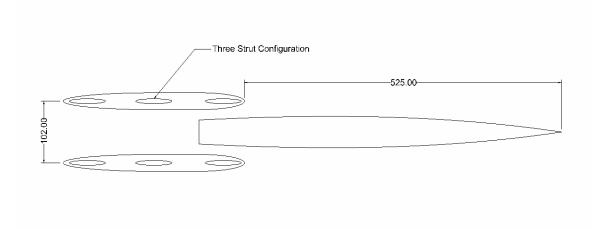


Figure 191. Optimized Small Waterplane Area Trimaran Configuration

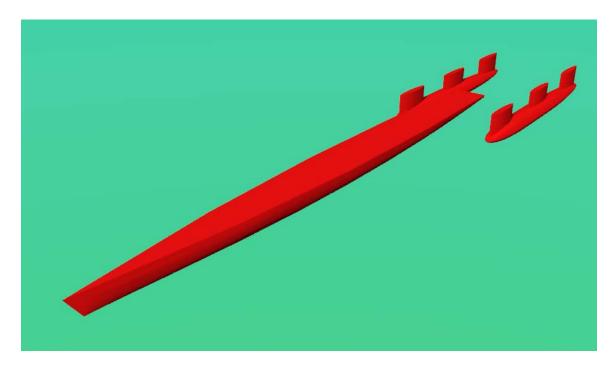


Figure 192. Optimized Small Waterplane Area Trimaran Perspective

B. RECOMMENDATIONS

The study of the optimized configuration of a small waterplane area trimaran was performed in response to the numerous concept designs put out by various Department of Defense and Department of Transportation agencies. This study lays the ground work for further development of the small waterplane area trimaran hull design for large displacement vessels. In order to facilitate a progressive technical development process geared to this innovative design, a series of analytical studies must be implemented.

- 1. An analytic study should be conducted with the use of the DDG1000 hull as the center hull with the small waterplane area side hulls to determine the feasibility of an interchangeable modular design with the next generation cruiser CG(X).
- 2. Further CFD analysis should be conducted to determine optimal draft configurations to ensure minimum flow interferences with the submerged side hull pods and the center hull.
- 3. A thorough validation of calculational results with a scaled model of the optimized configuration through a series of tow tank tests and subsequent analysis should be conducted.
- 4. A finite element analysis of the overall design solving for the static and dynamic responses from longitudinal, transverse, and twisting load conditions to determine the detailed structural design should be conducted.
- 5. A dynamic stability analysis of the optimized design to provide a validation for the use of small waterplane area trimaran hulls as a viable platform to reduce ship motion in waves and further present an formidable alternative to other ship configurations in heavy sea states should be conducted.

APPENDIX A: SWAN2 TOTAL HULL OUTPUT FILES

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                                 Massachusetts Institute of Technology
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        12
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        16
        16
        256
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_____
                                 PRINCIPAL HYDROSTATIC PARTICULARS
      density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
                     Waterline Length (m): 4.134E+2
Waterline Beam (m): 4.416E+1
Maximum Draft (m): 1.033E+1
Displacement (m^3): 1.447E+4
Wetted Surface Area (m^2): 8.569E+3
LCB (from origin) (m): 8.918E+1
TCB (from origin) (m): 0.000E+0
VCB (from origin) (m): -3.716E+0

Waterplane Area (m^2): 2.593E+3
LCF (from origin) (m): 9.553E+1
Metacentric height (m): 7.394E+0

Mass (kg): 1.200E+7
                                       Mass (kg) : 1.200E+7

Mass/density (m^3) : 1.171E+4

LCG (from origin) (m) : 9.929E+1

TCG (from origin) (m) : 0.000E+0

VCG (from origin) (m) : -3.947E+0

Radii of Gyration (m) : 0.000E+0 (roll)

(about CG) (m) : 0.000E+0 (pitch)

(m) : 0.000E+0 (yaw)
                                      STEADY FORCE AND RESPONSE
                      Ship Speed (m/s): 7.720E+0
Ship Speed (knots): 1.499E+1
Wetted Surface Area (m^2): 8.569E+3
Rw (kN): 9.543E+1
Cw : 3.646E-4
Sinkage (m): 3.202E+0
Trim at CG (deg): 1.322E+0
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dens	ity (kg/m	^ 3)= 1025	.000	gravity	PARTICULAR (m/s^2) =	9.80
	Wata	rline Ler	at h	(m)	. / 13/	 E+2
	Wate	rline Bea	ım	(m)	: 4.416	E+1
	Maxi	mum Draft	:	(m)	: 1.033	E+1
	Disp	lacement		(m^3)	: 1.447	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.567	E+3
	LCB	(from ori	gin)	(m)	: 8.918	E+1
	TCB	(from ori	gin)	(m)	: 0.000	E+0
	VCB	(from ori	.g1n) 	(m)	: 4.416 : 1.033 : 1.447 : 8.567 : 8.918 : 0.000 : -3.716	止+∪ ·
	Wate	rplane Ar (from ori centric h	ea	(m^2)	: 2.590	E+3
	LCF	(from ori	gin)	(m)	: 9.564 : 7.391	E+1
	Meta	centric h	eight	(m)	: 7.391	
· 	Mass	-		(kg)	: 1.200: : 1.171: : 9.929: : 0.000: -3.947: 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 9.929	E+1
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(Irom ori	gin)	(m)	: -3.947	≝+U -/~~~~
	raull Ol	+ CG/ - GALACIO:	11	(III) :	0.000E+0	(TOT)
	(abou	c cg/		(m) :	0.000E+0	(vaw
		rs	'EADY	FORCE ANI	RESPONSE	
	Shin	Speed		(m/s)	: 1.028	E+1
	Ship	Speed		(knots)	: 1.996	E+1
	Wett	ed Surfac	e Are	a (m^2)	: 8.567	E+3
	Rw			(kN)	: 1.028 : 1.996 : 8.567 : 1.907	E+2
	Cw				: 4.110	E-4
	Sink	age at CG		(m) (deg)	: 3.284 : 1.386	E+0

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	3 4	55	12	660	2	1
	4 5	14 14	7	98	5 5	1
	6	12	12	144	1	0
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dens	sity (kg/m	$1^3) = 1025$	AL HIL	gravity	PARTICULA (m/s^2) =	9.80
	Wate	rline Ber	ig cii	(III)	. 4.13	±⊡+∠ 1 ☑ ⊥ 1
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	Dist	lacement	•	(m^3)	. 1.05	RE+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.51	1E+3
	LCB	(from ori	.gin)	(m)	: 9.28	1E+1
	TCB	(from ori	gin)	(m)	: 0.000	0E+0
	VCB	(from ori	.gin)	(m)	: 4.13 : 4.42 : 1.03 : 1.38 : 8.51 : 9.28 : 0.00 : -3.53	9E+0
	Wate	rplane Ar	rea	(m^2)	: 2.590 : 9.540 : 7.810	6E+3
	LCF	(from ori	.gin)	(m)	: 9.548	3E+1
	Meta 	centric h	neight 	(m)	: 7.81	OE+0
	Mass	\$		(kg)	: 1.200 : 1.17: : 9.929 : 0.000 : -3.94' 0.000E+0 0.000E+0	0E+7
	Mass	density		(m^3)	: 1.17	1E+4
	LCG	(from ori	.gin)	(m)	: 9.92	9E+1
	TCG	(from ori	.gin)	(m)	: 0.000	0E+0
	VCG	(from ori	.gin)	(m)	: -3.94	7E+0
	Radii o	f Gyratio	n	(m) :	0.000E+0	(rol.
	(abou	It CG)		(m) :	0.000E+0 0.000E+0	(pitc
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_	Ship	Speed Speed		(m/s)	: 1.28	6E+1
	Ship	Speed		(knots)	: 2.49	7E+1
	Wett	ed Surfac	e Are	a (m^2)	: 8.51	1E+3
	Rw			(kN)	: 2.49° : 8.51° : 8.55° : 1.18°	9E+2
	Cw			/ \	: 1.18	/E-3
		age m at CG		(m)	: 1.626 : 6.80	o E+U

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de	nsity (kg/m	^ 3)= 102.	5.000	gravity	$(m/s^2) =$	9.80
	Mata	rlino Io	na+h	(m)	. / 12/	E+2
	Wate	rline Be	am	(m)	: 4.421	E+1
	Maxi	mum Drai	τ	(m) (m^2)	: 1.033	E + 1
	Mett	ed Surfa	ce Are	(III 3) a (m^2)	. 2.300	E+4
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	TCB	(from or	igin)	(m)	: 0.000	E+0
	VCB	(from or	igin)	(m)	: 4.421 : 1.033 : 1.388 : 8.511 : 9.281 : 0.000 : -3.539	E+0
	Wate	rplane A	rea	(m^2)	: 2.596 : 9.548 : 7.810	E+3
	LCF	(from or	igin)	(m)	: 9.548	E+1
	Meta	centric	height	(m)	: 7.810	E+0
	Mass			(kg)	: 1.200 : 1.171 : 7.929 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+7
	Mass	/density	i ~ i ~ \	(m ² 3)	: 1.171	E+4
	LCG TCC	(from or	igin)	(m)	. 7.929	E + U
	ACG 1.CG	(from or	igin)	(III) (m)	. 0.000	E+0
	Radii of	Gyratic	n n	(m) :	0.000E+0	(roll
	(abou	t ĆG)		(m) :	0.000E+0	(pitc
		•		(m) :	0.000E+0	(yaw
			 TEADY	FORCE AND	RESPONSE	
	Oh i					 17.1
	Snip	speed		(m/s)	: 1.491	E+1
	Snip Watt	speed ed Surfa	ce 7ro	(KIIOES)	: ∠.895	Ľ T .5 □ + Ţ
	Rw.	ca burra	ce Are	u (111 ∠) (kN)	: 1.491 : 2.895 : 8.511 : 3.932	E+2
	Cw					E-4
	Sink	age		(m)	: -4.567	

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2 19 80 1520 3	0 1
3 55 12 660 2 4 14 7 98 5	1
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6 12 12 144 1	0
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Waterline Beam (m): 4.421 Maximum Draft (m): 1.033	.E+1 :R⊥1
Displacement (m^3): 1.388	E+4
Wetted Surface Area (m^2) : 8.511	E+3
LCB (from origin) (m): 9.281	E+1
Waterline Beam (m): 4.134 Waterline Beam (m): 4.421 Maximum Draft (m): 1.033 Displacement (m^3): 1.388 Wetted Surface Area (m^2): 8.511 LCB (from origin) (m): 9.281 TCB (from origin) (m): 0.000 VCB (from origin) (m): -3.539)E+0)E+0
Waterplane Area (m^2): 2.596	E+3
Waterplane Area (m^2) : 2.596 LCF $(from \ origin)$ (m) : 9.548 Metacentric height (m) : 7.810	E+0 E+1
Mass (kg) : 1.200	E+7
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TCG (from origin) (m) : 0.000	E+0
VCG (from origin) (m) : -3.947	'E+0
Radii of Gyration (m) : 0.000E+0	(roll)
Mass (kg) : 1.200 Mass/density (m^3) : 1.171 LCG (from origin) (m) : 9.929 TCG (from origin) (m) : 0.000 VCG (from origin) (m) : -3.947 Radii of Gyration (m) : 0.000E+0 (about CG) (m) : 0.000E+0 (m) : 0.000E+0	(pitch)
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STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.800 Ship Speed (knots): 3.495 Wetted Surface Area (m^2): 8.511 RW (kN): 1.819	E+1 E+1 E+3 E+3

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	5 14	7	98	3 3 2 5 5	1
	6 12	12	144	1	0
dongitu	PRINCIP $(kg/m^3) = 1025$	AL HYI	DROSTATIC	PARTICULAI	RS a on
	Waterline Ler Waterline Bea Maximum Draft Displacement Wetted Surfac LCB (from or: TCB (from or: VCB (from or:	ngth	(m)	: 4.134	E+2
	Waterline Bea	am	(m)	: 4.421	E+1
	Maximum Draft	5	(m)	: 1.033	E+1
	Displacement		(m^3)	: 1.388	E+4
	Wetted Surface	ce Are	a (m^2)	: 8.511	E+3
	LCB (from or:	igin)	(m)	: 9.912	E+1
	TCB (from or:	lgin)	(m)	: 0.000	E+0
	VCB (Irom or	lgin) 	(m)	: -3.539	E+0
	Waterplane And LCF (from or: Metacentric h	rea	(m^2)	: 2.596	E+3
	LCF (from or:	igin)	(m)	: 9.691	E+1
	Metacentric h	neight	(m)	: 7.810	E+0
	Mass Mass/density LCG (from or: TCG (from or: VCG (from or: lii of Gyratio (about CG)		(ka)	: 1.200	E+7
	Mass/density		(m^3)	1.171	E+4
	LCG (from or	iain)	(m)	: 9.929	E+1
	TCG (from or:	igin)	(m)	: 0.000	E+0
	VCG (from or:	igin)	(m)	: -3.947	E+0
Rad	lii of Gyratio	n ,	(m) :	0.000E+0	(rol]
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	Chin Cnood		(m/a)	. 7 700	
	Ship Speed Ship Speed		(III/S)	: 7.720	⊡+U □.1
	Snip Speed	70 7	(KNOTS)	: 1.499	E+1
	Ship Speed Ship Speed Wetted Surface Rw	e are	a (III ∠) (leN)	: 8.511	E+3
	L'M		(KIN)	. 3.53/	Б+Z
	Cw Sinkage		(m) (deg)	: 1.360 : 5.816	

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	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7 7	98 98	5	1
	6		12	144		0
		PRTNCTD:	AI, HVF	ROSTATIC	PARTTCIII.AI	 RS
dens	sitv (ka/m	$^{1}(1)(1)$.000	gravity	PARTICULAR (m/s^2) =	9.80
	Wate	rline Len	gth	(m)	: 4.134	E+2
	Wate	rline Bea	.m	(m)	: 4.421	E+1
	Maxi	mum Draft		(m)	: 1.033	E+1
	Disp	lacement	-	(m^3)	: 1.388	E+4
	Wett	ed Surfac	e Are	a (m ²)	: 8.511	E+3
	TCB	(from ori	gin)	(m)	: 9.912	E+1
	VCB	(from ori	gin)	(III) (m)	: 0.000	E+0
			.g,		: 4.134 : 4.421 : 1.033 : 1.388 : 8.511 : 9.912 : 0.000 : -3.539	
	Wate	rplane Ar	ea	(m^2)	: 2.596	E+3
	LCF	(from ori	gin)	(m)	: 9.691	E+1
	Meta	centric h	eight	(m)	: 2.596 : 9.691 : 7.810	E+0
	Maga			(ka)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	 F±7
	Magg	/dengit:		(m^3)	. 1.200	±+/
	11.CC	(from ori	ain)	(111 3) (m)	. 9 920	± E+1
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	E+0
	Radii of	f Gyration	j, 1	(m) :	0.000E+0	(roll
	(abou	t ĆG)		(m) :	0.000E+0	(pitc
				(m) :	0.000E+0	(yaw
					RESPONSE	
					: 1.028 : 1.996 : 8.511 : 8.920 : 1.935 : 3.700	
	Ship	Speed		(m/s)	: 1.028	E+1
	Ship	Speed	_	(knots)	: 1.996	E+1
	Wett	ed Surfac	e Are	a (m^2)	: 8.511	E+3
	Rw			(KN)	: 8.920	E+2
	Cw			()	: 1.935 : 3.700 : -1.647	E-3
	Sink	age		(m)	: 3./00	$H_{i} = 1$
	=-:	at CG		() (

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*	SWA	N2 2002	SOLVE		*
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* * * * * * * * * * * * * * * * * * * *	*****	*****	*****	*****	* *****
			GRID INFO	RMATION	
	Name	:	tsuR066	SSG File	
She	et# NP1	NP2	NP	KP	MP
	1 6	80	480 1520 660	3 3	0
	2 19	80	1520	3	0
		12	660	2 5	1
	4 14 5 14		98 98	5	1 1
	6 12			1	0
a	PRINC	IPAL HY	DROSTATIC	PARTICULAR:	S
density	(kg/m ³) = 1				
	Waterline 1	Length	(m)	: 4.134E	E+2
	Waterline l	Beam	(m)	: 4.421E	6+1 3.1
	Dignlacemen	dil nt	(III)	: 1.033E	5+1 7±4
	Wetted Sur	face Are	a (m^2)	: 8.511E	3+4 3+3
	LCB (from o	origin)	(m)	: 9.912E	E+1
	TCB (from o	origin)	(m)	: 0.000E	E+0
	VCB (from o	origin) 	(m) 	: 4.134E : 4.421E : 1.033E : 1.388E : 8.511E : 9.912E : 0.000E : -3.539E	E+0
	Waterplane	Area	(m^2)	: 2.596E : 9.691E : 7.810E	E+3
	LCF (from o	origin)	(m)	: 9.691E	E+1
	Mass Mass/densit LCG (from of TCG (from of VCG (from of Lii of Gyrat (about CG)		(kg)	: 1.200E	E+7
	Mass/densi	ty	(m^3)	: 1.171E	E+4
	LCG (from o	origin)	(m)	: 9.929E	5+1
	VCG (from o	origin)	(m)	: -3.947E	I + O
Rad	lii of Gyrat	ion	(m) :	0.000E+0	(roll)
	(about CG)		(m) :	0.000E+0 ((pitch)
			(m) :	0.000E+0	(yaw)
		STEADY	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.286E	 :+1
	Ship Speed		(knots)	: 2.497E : 8.511E	3.1 E+1
	Wetted Sur	face Are	a (m^2)	: 8.511E	E+3
	Rw		(kN)	: /.248E	5+2
	Cw		()	: 1.005E	
	Sinkage Trim at CG		(m) (deg)	: 9.807E : 1.700E	
	ייייוו מנ כפ		(ueg)	. I./UUE	2 - T

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*	SWA	N2 2002	SOLVE		*
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******	******	*****	*****	*****	*****
	Name		GRID INFO		
Shee	et# NP1 1 6	NP2	NP	KP	MP 0
	2 19	80	480 1520 660	3	0
	2 19 3 55	12	660	2 5	1
	4 14	./	98	5	1
	5 14	7	98	5	1
	6 12	12	144	1	0
	DDING				
density ($kg/m^3) = 10$	025.000	gravity	PARTICULAR (m/s^2) =	9.800
	Waterline D	Length	(m)	: 4.134E	 E+2
	Waterline 1	Beam	(m)	: 4.421E	E+1
	Maximum Dra	aft	(m)	: 1.033E	E+1
	Displacemen	nt .	(m^3)	: 1.388E	I+4
	Wetted Sur	tace Are	a (m 2)	: 8.511E	≦+3 7±1
	TCB (from a	origin)	(m)	. 0.000F	Z+O
	VCB (from o	origin)	(m)	: 4.421E : 1.033E : 1.388E : 8.511E : 9.912E : 0.000E : -3.539E	E+0
	LCF (from o	origin)	(m)	: 2.596E : 9.691E : 7.810E	E+1
	Mass		(kg)	: 1.200E : 1.171E : 9.929E : 0.000E : -3.947E 0.000E+0 0.000E+0	 E+7
	Mass/densi	-y	(m^3)	: 1.171E	E+4
	LCG (from o	origin)	(m)	: 9.929E	I+1
	ICG (IYOM (origin)	(m) (m)	: U.UUUE	5+O 5+0
Radi	i of Gvrat	ion	(m) :	0.000E+0	(roll)
(about CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
		STEADY	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.543E	
	Ship Speed		(knots)		
	Wetted Sur:	face Are	a (m^2)	: 2.996E : 8.511E	E+3
	Rw		(kN)	. 1.22/	1+3
	Cw Sinkage		(m)	: 1.181E : 3.290E	
	Trim at CG		(deg)	: 1.363E	
			,		-

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*	SWAINZ	2002	SOLVE		
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*	*****	*****	******	*****	*****
	Name		GRID INFO	SSG File	
Sh	eet# NP1 1 6 2 19 3 55 4 14 5 14	NP2	NP	KP	MP
	1 6	80	480	3	0
	2 19	80	1520	3	0
	3 55	12	660	2	1
	4 14	7	98	5	1
	5 14 6 12	1.7	98 144	5 1	1 0
	0 12				
	DDTMCTD	7. UVI	DOSTATIC	PARTICULA	 DC
density	$(kg/m^3) = 1025$	5.000	gravity	$(m/s^2) =$	9.800
	Waterline Ler Waterline Bea Maximum Draft Displacement Wetted Surfac LCB (from ori TCB (from ori VCB (from ori	ngth	(m)	: 4.134	E+2
	Waterline Bea	am	(m)	: 4.421	E+1
	Maximum Draft	;	(m)	: 1.033	E+1
	Displacement		(m^3)	: 1.388	E+4
	Wetted Surface	ce Are	a (m^2)	: 8.511	E+3
	LCB (from ori	igin)	(m)	: 9.912	E+1
	TCB (from or	lgin)	(m)	: 0.000	E+0
	(11011 O11		(III)	: -3.539	'E+U
	Waterplane An LCF (from ori Metacentric h	rea	(m^2)	: 2.596	E+3
	LCF (from or	lgin)	(m)	: 9.691	E+1
	Metacentric h	neight	(m)	: 7.810	E+0
	Mass Mass/density LCG (from ori TCG (from ori VCG (from ori dii of Gyratio (about CG)		(kg)	: 1.200	E+7
	Mass/density		(m^3)	: 1.171	E+4
	LCG (from ori	lgin)	(m)	: 9.929	E+1
	TCG (from ori	igin)	(m)	: 0.000	E+0
	VCG (from ori	lgin)	(m)	: -3.947	E+0
Ra	dii of Gyratio	n	(m) :	0.000E+0	(roll)
	(about CG)		(m) :	0.000E+0	(pitcn)
			((((((((((((((((((((0.000±+0	(yaw)
			EODCE AND	DECDONCE	
	Ship Speed Ship Speed Wetted Surface Rw Cw Sinkage	I	· · · · · · · · · · · · · · · · · · ·	RESPONSE	
	Ship Speed		(m/s)	: 1.800	E+1
	Ship Speed		(knots)	: 3.495	E+1
	Wetted Surfac	ce Are	a (m^2)	: 8.511	E+3
	Rw		(kN)	: 2.645	E+3
	Cw			: 1.871	E-3
			(m) (deg)	: 3.984 : 1.844	E+0
	Trim at CG		(deg)	: 1.844	E+0

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*	SW	AN2 2002	SOLVE		*
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			GRID INFO	RMATION	
	Name	e :	tsuR066	SSG File	
She	et# NP1	NP2	NP	KP	MP
	1 6	80	480 1520 660	3 3 2 5	0
	2 19	80	1520	3	0
		12	660	2	1 1
	4 14 5 14		98 98	5	1
	6 12			1	0
dengity	PRIN(CIPAL HY	DROSTATIC	PARTICULAR (m/s^2) =	S 9 800
	Waterline	Length	(m)	: 4.134E	E+2
	Waterline	Beam	(m)	: 4.421E	3+1
	Maximum Dr	all nt	(III)	1.0335	5+1 7:4
	Wetted Sur	iii face Are	(III 3) (m^2)	. 9 5115	7±3 7±4
	LCB (from	origin)	(m)	: 1.125E	3+2
	TCB (from	origin)	(m)	: 0.000E	Z+0
	VCB (from	origin)	(m)	: 4.134E : 4.421E : 1.033E : 1.388E : 8.511E : 1.125E : 0.000E : -3.539E	E+0
	Waterplane	Area	(m^2)	: 2.596E : 9.997E : 7.810E	 E+3
	LCF (from	origin)	(m)	: 9.997E	E+1
	Mass		(kg)	: 1.200E : 1.171E : 9.929E : 0.000E : -3.947E 0.000E+0 0.000E+0	 E+7
	Mass/densi	ty	(m^3)	: 1.171E	C+4
	LCG (from	origin)	(m)	: 9.929E	E+1
	TCG (from	origin)	(m)	: 0.000E	S+0
Dad	ved (IFOM	-ion origin)	(III)	0.000E+0	1+∪ (roll)
Rau (iabout CG)	-1011	(m) ·	0.000E+0 0.000E+0	(nitch)
`	about co,		(m) :	0.000E+0	(yaw)
		STEADY	FORCE AND	RESPONSE	
	Chin Con-		(m/s)	. 7 700	
	Ship Speed Ship Speed	<u>.</u>	(m/s)	: 7.720E : 1.499E : 8.511E : 1.767E : 6.796E : -2.845E	5+∪ 7+1
	Wetted Sur	face Are	a (m^2)	. 1.433E	3+3
	Rw		(kN)	: 1.767E	Z+2
	Cw		,	: 6.796E	E-4
	Sinkage		(m)	: -2.845E	E+0
	Trim at CG		(deg)	: -2.061E	E+0

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		SWAN2	2002	SOLVE				
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	Massa	chusetts	Insti	tute of	Technology			
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		GRID INFORMATION						
					SSG File			
	Sheet#	NP1			KP	MP		
	1	6	80	480	3	0		
	2	19	80	NP 480 1520	3 3 2	0		
	3	55	12	860	4	1		
	4	14	7		5	1		
	5	14	7	98	5	1		
	6 	12		144	1 	0		
		PRINCIP	AL HYD	ROSTATIC	PARTICULAR	RS		
densi	ty (kg/m	^3)= 1025	.000	gravity	$(m/s^2) =$	9.800		
	Wate	rline Ler	at h	(m)	. / 13/	E+2		
	Wate:	rline Bea	ım	(m)	: 4.421	E+1		
	Maxi	mum Draft		(m)	: 1.033	E+1		
	Disp	lacement		(m^3)	: 1.388	E+4		
	Wett	ed Surfac	e Are	a (m^2)	: 8.511	E+3		
	LCB	(from ori	gin)	(m)	: 1.125	E+2		
	TCB	(from ori	gin)	(m)	: 0.000	E+0		
					: 4.421 : 1.033 : 1.388 : 8.511 : 1.125 : 0.000 : -3.539			
	Wate:	rplane Ar	ea	(m^2)	: 2.596 : 9.997 : 7.810	E+3		
	LCF	(from ori	gin)	(m)	: 9.997	E+1		
	Mass			(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+7		
	Mass	/density		(m^3)	: 1.171	E+4		
	LCG	(from ori	gin)	(m)	: 9.929	E+1		
	TCG	(from ori	gin)	(m)	: 0.000	E+0		
	VCG	(from ori	gin)	(m)	: -3.947	E+0		
	Radii of	Gyratio:	n	(m) :	0.000E+0	(roll		
	(abou	t CG)		(m) :	0.000E+0	(pitch		
				(m) :	0.000E+0	(yaw)		
-		-		-	-	-		
		ST	EADY	FORCE AND	RESPONSE			
	Ship	Speed		(m/s)	: 1.028	E+1		
	Ship	Speed Speed		(knots)	: 1.996	E+1		
	Wett	ed Surfac	e Are	a (m^2)	: 1.028 : 1.996 : 8.511 : 1.956	E+3		
	Rw			(kN)	: 1.956	E+2		
	Cw				: 4.243	E-4		
	Sink	age		(m) (deg)	: -2.431 : -1.832	E+0		

k *		SWAN2	2002	SOLVE				
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t								
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•	Massa	cnusetts	Insti	tute or	Technology			
*****	*****	*****	*****	*****	*****	*****		
				GRID INFO	ORMATION			
		Name			SSG File			
	Sheet#	NP1	NP2	NP	KP	MP		
	1	6	80	480	3	0		
	2	19	80	480 1520 660 98	3 2	0		
	3	55	12	660	2	1		
	4	14	7	98 98	5	1		
	5 6	14	7	98 144	5	1		
	b	12			1	0		
	(1/	PRINCIP	PAL HYI	ROSTATIC	PARTICULA	RS		
aens11					(m/s^2) =	9.800		
	Wate:	rline Le	ngth	(m)	: 4.134	1E+2		
	Wate:	rline Bea	am	(m)	: 4.421E+1			
	Maxi	mum Draft	t	(m)	: 1.033	: 1.033E+1		
	Dien	Displacement						
	DISP.	lacement		(m^3)	: 1.388	3E+4		
	Wette	lacement ed Surfa	ce Are	(m^3) a (m^2)	: 1.388	BE+4 LE+3		
	Wette LCB	lacement ed Surfa (from or:	ce Are	(m) (m) (m) (m^3) a (m^2) (m)	: 1.388 : 8.511 : 1.125	BE+4 LE+3 5E+2		
	Wette LCB TCB	lacement ed Surfac (from or: (from or:	ce Are igin) igin)	(m ³) a (m ²) (m) (m)	: 1.388 : 8.511 : 1.125 : 0.000	BE+4 LE+3 5E+2 DE+0		
	Wette LCB TCB VCB	lacement ed Surfac (from or: (from or:	ce Are	(m ³) a (m ²) (m) (m) (m)	: 1.388 : 8.511 : 1.125 : 0.000 : -3.539	BE+4 LE+3 SE+2 DE+0 PE+0		
	TCB VCB	(from or:	igin) igin)	(m) (m)	: 0.000	5E+2)E+0 9E+0		
	TCB VCB	(from or:	igin) igin)	(m) (m)	: 0.000	5E+2)E+0 9E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or:	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height	(m) (m) (m) (m^2) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2 0E+0 9E+0 5E+3 7E+1 0E+0		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height igin) igin) igin) igin)	(m) (m) (m) (m) (m) (m) (m) (m) (m) (m)	: 0.000 : -3.539 : 2.596 : 9.997 : 7.810	5E+2)E+0 5E+3 7E+1)E+0 DE+7 LE+4 9E+1 DE+0 (roll		
	TCB VCB Wate: LCF Meta	(from or: (from or: rplane A: (from or: centric	igin) igin) rea igin) height igin) igin) igin) igin)	(m) (m) (m) (m) (m) (m) (m) (m) (m) (m)	: 0.000 : -3.533 : 2.596 : 9.99 : 7.810 : 1.200 : 1.177 : 9.929 : 0.000 : -3.947 0.000E+0	5E+2)E+0 5E+3 7E+1)E+0 DE+7 LE+4 9E+1 DE+0 (roll		
	TCB VCB Wate: LCF Meta	(from or (from or	igin) igin) rea igin) height igin) igin) igin) igin)	(m) (m) (m) (m) (m) (kg) (m/3) (m) (m) (m) (m) : (m) :	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.200 : 1.177 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0	5E+2)E+0 5E+3 7E+1)E+0 DE+7 LE+4 9E+1 DE+0 (roll		
	TCB VCB Wate: LCF Meta	(from or (from or	igin) igin) rea igin) height igin) igin) igin) igin)	(m) (m) (m) (m) (m) (kg) (m/3) (m) (m) (m) (m) : (m) :	: 0.000 : -3.533 : 2.596 : 9.99 : 7.810 : 1.200 : 1.177 : 9.929 : 0.000 : -3.947 0.000E+0	5E+2)E+0 5E+3 7E+1)E+0 DE+7 LE+4 9E+1 DE+0 (roll		
	TCB VCB Wate: LCF Meta: Mass Mass, LCG TCG VCG Radii of (about	(from or: (from or: rplane A: (from or: centric l /density (from or: (from or: (from or: certric l	igin) igin) rea igin) height igin) igin) igin) igin) irini	(m) (m) (m) (m) (m) (m) (m) (m) (m) (m)	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.200 : 1.177 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0	SE+2 DE+0 DE+0 SE+3 SE+1 DE+0 DE+7 DE+7 DE+4 DE+0 (roll (pitch) (yaw)		
	TCB VCB Wate: LCF Metac Mass Mass, LCG TCG VCG Radii of (about	(from or (from or centric) /density (from or (from or (from or (from or Gyratic t CG)	igin) igin) rea igin) height igin) igin) igin) igin) ir	(m) (m) (m) (m) (m) (kg) (m/3) (m) (m) (m) (m) (m) : (m) : (m) : (m) :	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.177 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	SE+2 DE+0 DE+0 SE+3 VE+1 DE+0 DE+0 OE+7 DE+7 DE+1 DE+0 (roll (pitch) (yaw)		
	TCB VCB Wate: LCF Metac Mass Mass, LCG TCG VCG Radii of (about	(from or (from or centric) /density (from or (from or (from or (from or Gyratic t CG)	igin) igin) rea igin) height igin) igin) igin) igin) ir	(m) (m) (m) (m) (m) (m) (m) (m)	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.177 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	SE+2 DE+0 DE+0 SE+3 VE+1 DE+0 DE+0 OE+7 DE+7 DE+1 DE+0 (roll (pitch) (yaw)		
	TCB VCB Wate: LCF Meta Mass Mass, LCG TCG VCG Radii of (about	(from or (from or centric) /density (from or (from or (from or (from or Gyratic t CG)	igin) igin) rea igin) height igin) igin) igin) igin) ir	(m) (m) (m) (m) (m) (kg) (m/3) (m) (m) (m) : (m) : (m) : (m) : (m) : (m) :	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.177 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	SE+2 DE+0 DE+0 SE+3 VE+1 DE+0 DE+7 UE+4 DE+0 (roll (pitch) (yaw)		
	TCB VCB Wate: LCF Metac Mass Mass, LCG TCG VCG Radii of (about)	(from or. (from or. (from or. centric) (from or. (from	igin) igin) igin) rea igin) height igin) igin) igin) igin) ir	(m) (m) (m) (m) (m) (kg) (m) (m) (m) (m) (m) : (m) : (m) : (m) : (m) : (m) :	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.200 : 1.177 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	SE+2 DE+0 DE+0 DE+0 DE+1 DE+1 DE+1 DE+1 DE+1 DE+0 (roll) (pitch) (yaw) SE+1 DE+1 DE+1 DE+1 DE+1 DE+1 DE+1 DE+1 D		
	TCB VCB Wate: LCF Metac Mass Mass, LCG TCG VCG Radii of (about) Ship Ship Wettc Rw Cw Sinka	(from or (from or centric) /density (from or (from or (from or (from or Gyratic t CG)	igin) igin) igin) rea igin) height igin) igin) igin) igin) ir	(m) (m) (m) (m) (m) (m) (m) (m)	: 0.000 : -3.533 : 2.596 : 9.997 : 7.810 : 1.200 : 1.177 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	SE+2 DE+0 DE+0 DE+0 DE+1 DE+1 DE+1 DE+1 DE+1 DE+0 (roll) (pitch) (yaw) DE+1 TE+1 DE+1 DE+1 DE+0 DE+1 DE+0 DE+0 DE+0 DE+0 DE+0 DE+0 DE+0 DE+0		

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	SWA	N2 2002	SOLVE		
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	*****	ale ale ale ale ale ale ale ale			
****	*****	******		****	*****
			GRID INFO		
	Name	:	tsuR066	SSG File	
Sho	eet# NP1			KP	MP
	1 6	80	480	3	0
	2 19	80	NP 480 1520	3 3 2	0
	3 55	12	660	2	1
	4 14			5	1
	5 14		98	5	1
	6 12 	12	144	1	0
	PRINC	IPAL HYI	ROSTATIC	PARTICULA	RS
density	(kg/m ³) = 10	025.000	gravity	(m/s^2)=	9.800
	Waterline I	.onath	(m)	. / 13/	E+2
	Waterline H	3eam	(m)	: 4.421	E+1
	Maximum Dra	aft	(m)	: 1.033	E+1
	Displacemen	ıt	(m^3)	: 1.388	E+4
	Wetted Surf	tace Are	a (m^2)	: 8.511	E+3
	LCB (from o	origin)	(m)	: 1.125	E+2
	Waterline I Maximum Dra Displacemer Wetted Surf LCB (from o TCB (from o VCB (from o	origin)	(m)	: 0.000	E+0
	Waterplane	Area	(m^2)	: 2.596	E+3
	Waterplane LCF (from o Metacentric	origin)	(m)	: 9.997	E+1
	Mass	·	(kg)	: 1.200	E+7
	Mass/densit	-У	(m^3)	: 1.171	E+4
	I.CG (from c	origin)	(m)	9 929	D . 1
	ECG (IIOM ((111)	. ,,,,,,,	T
	TCG (from o	origin)	(m)	: 0.000	E+0
_	TCG (from c	origin)	(m) (m)	: 0.000 : -3.947	E+0 E+0
Rac	TCG (from over the control of Gyrat	origin) origin) ion	(m) (m) (m) :	: 0.000 : -3.947 0.000E+0	E+0 E+0 (roll
Rac	TCG (from o VCG (from o lii of Gyrat (about CG)	origin) origin) ion	(m) (m) (m) : (m) :	: 0.000 : -3.947 0.000E+0 0.000E+0	E+0 (roll (pitcl
Rac	Mass Mass/densit LCG (from of TCG (from of VCG (from of dii of Gyrat (about CG)	origin) origin) ion	(m) (m) (m) : (m) : (m) :	: 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+1 E+0 E+0 (roll (pitcl
Rac	TCG (from (VCG (from di) of Gyrat (about CG)	origin) origin) ion	(m) (m) : (m) : (m) :	: 0.000 : -3.947 0.000E+0 0.000E+0	E+1 E+0 (E+0 (roll (pitch (yaw)
Rac	TCG (from c VCG (from c dii of Gyrat (about CG)	origin) origin) origin) ion	(m) (m) (m) : (m) : (m) :	0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+1 E+0 E+0 (roll (pitch (yaw)
Rad	TCG (from c VCG (from c dii of Gyrat (about CG)			: 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+1 E+0 E+0 (roll (pitch (yaw)
Rac		STEADY	FORCE AND) RESPONSE	
Rac		STEADY	FORCE AND) RESPONSE	
Rad		STEADY	FORCE AND) RESPONSE	
Rac		STEADY	FORCE AND) RESPONSE	
Rac	Ship Speed Ship Speed Wetted Suri	STEADY	FORCE AND	RESPONSE : 1.543 : 2.996 : 8.511 : 5.028	E+1 E+1 E+3 E+2
Rac		STEADY	FORCE AND) RESPONSE	E+1 E+1 E+3 E+2 E-4

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*		SWAWS	2002	SOLVE		
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*****	*****	*****	****	******	*****	*****
				GRID INF		
		Name	:	tsuR066	SSG File	
S	heet#		NP2	NP	KP	MP
	1	6	80	480	3	0
	2	19	80	1520 660 98	3 2	0
	3 4	55	12	660	∠ 5	1 1
	4 5	14	7	98 98	5 5	1
	5 6	14 12	1 2	144	1	0
					י האסתדמווי	
A	. /1 / /	PKINCIP	ап наг	JKUSTATIC	PARTICULA	'KS
density	/ (kg/m	3) = 1025	.000	gravity 	(m/s^2) =	9.800
	Wate	rline Ler	ngth	(m) (m) (m) (m^3) (a (m^2)	: 4.13	4E+2
	Water	rline Bea	am	(m)	: 4.42	1E+1
	Maxir	mum Draft		(m)	: 1.03	3E+1
	Disp.	lacement		(m^3)	: 1.38	3E+4
	Wette	ed Surfac	ce Are	a (m^2)	: 8.51	1E+3
	LCB	(from ori	igin)	(m)	: 1.12	5E+2
	TCB	(from ori	igin)	(m)	: 0.00	0E+0
	VCB	(from ori	igin)	(m)	: 1.12 : 0.00 : -3.53	9E+0
	Water	rnlana Az		(m^2)	. 2 50	
	T.CF	(from ori	iain)	(III Z)	: 2.59 : 9.99	7F±1
	Metad	centric h	igin) ieiaht	(m^2) (m) (m)	: 7.81	7E+0
	Mass			(kg)	: 1.20	0E+7
	Mass	/density		(m^3)	: 1.17	1E+4
	LCG	(from ori	igin)	(m)	: 9.92	9E+1
	TCG	(from ori	lgin)	(m)	: 1.20 : 1.17 : 9.92 : 0.00 : -3.94 0.000E+0	0E+0
	VCG	(from ori	lgin)	(m)	: -3.94	7E+0
R	adii of	Gyratio	n	(m) :	0.000E+0	(roll)
	(about	t CG)		(m) :	0.000E+0	(pitch)
	(abca.					
	(about			(m) :	0.000E+) (yaw)
				(m) : 	0.000E+) (yaw)
				(m) : 	0.000E+) (yaw)
				(m) : 	0.000E+	0 (yaw)
				(m) : 	0.000E+) (yaw)
				(111) :	0.000E+) (yaw)
		Sī	 FEADY	FORCE AN	D RESPONSE	
		Sī	 FEADY	FORCE AN	D RESPONSE	 DE+1
	Ship	Speed Speed	 FEADY	FORCE AN: (m/s) (knots)	D RESPONSE	 0E+1
	Ship Ship Wette	Speed Speed	 FEADY	FORCE AN: (m/s) (knots) (a (m^2)	D RESPONSE	 0E+1
	Ship Ship Wette	Speed Speed	 FEADY	FORCE AN: (m/s) (knots)	D RESPONSE : 1.80 : 3.49 : 8.51 : 5.28	 0E+1 5E+1 1E+3 5E+2
	Ship Ship Wette Rw	Speed Speed Speed ed Surfac	 FEADY	FORCE AN (m/s) (knots) a (m^2) (kN)	D RESPONSE : 1.80 : 3.49 : 8.51 : 5.28 : 3.74	 DE+1 1E+3 5E+2 DE-4
	Ship Ship Wette Rw Cw Sinka	Speed Speed	 FEADY	FORCE AN: (m/s) (knots) (a (m^2)	D RESPONSE : 1.80 : 3.49 : 8.51 : 5.28	

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*****	*****	*****	*****	*****	*****
	Name	:	GRID INFO tsuR069	RMATION SSG File	
She	et# NP1 1 6	NP2	NP	KP	MP
	1 6	70	NP 420 1190 768	3	0
	2 17 3 48	7/0 1.6	1190	3	0 1
	4 12	7.0	768 108	2 5	1
	5 12	9 9	108	5	1
	6 16	16		1	0
density (PRINCII kg/m^3)= 102	PAL HYD 5.000	ROSTATIC gravity	PARTICULAR (m/s^2) =	.S 9.800
	 Waterline Le	nath	(m)	· 4 1341	 ₹+2
	Waterline Be Waterline Be	am	(m)	: 4.5821	3+2 3+1
	Maximum Draf	t	(m)	: 1.0331	3+1
	Displacement		(m^3)	: 1.447	∃ +4
	Wetted Surfa	ce Area	a (m^2)	: 8.569I	Ξ +3
	LCB (from or	igin)	(m) (m)	. 8.9181	5+U 5+T
	Waterline Le Waterline Be Maximum Draf Displacement Wetted Surfa LCB (from or TCB (from or	igin)	(m)	: -3.7161	Ξ+0
	Waterplane A LCF (from or Metacentric	igin)	(m)	: 9.5531	3+1
	Mass		(kg)	: 1.2001	 ∑+7
	Mass/density		(m^3)	: 1.1711	∃+4
	LCG (from or	igin)	(m)	9.9291	∃+1 Z.O
	VCG (from or	igin)	(III) (m)	3 947	5+0 3+0
Rad	ii of Gyratio	on	(m) :	0.000E+0	(roll)
(Mass Mass/density LCG (from or TCG (from or VCG (from or ii of Gyratic about CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch) (yaw)
	S	TEADY I	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 7.720H	 E+0
	Ship Speed		(knots)	: 1.4991	3+1
	Wetted Surfa	ce Area	a (m^2)	: 7.720I : 1.499I : 8.569I : 9.368I	Ξ +3
	Rw Cw		(kN)		
	Sinkage		(m)	: 3.2041	Ξ+0

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*****	****	*****	*****	*****	*****
	Name	:		ORMATION SSG File	
Sh	eet# NP1	NP2	NP	KP	MP
	1 6	70 70	420	3	0
	2 17	70	420 1190	3 3	0
	3 48	16	768	2	1
	4 12	9		5	1
	5 12	9	108	5	1
	6 16	16 	256 	1	0
density	PRINCI: $(kg/m^3) = 102$	PAL HYD	ROSTATIC	PARTICULAR	25 9 800
	Waterline Le	ength	(m)	: 4.134	E+2
	Waterline Be	eam	(m)	: 4.582	E+1
	Maximum Draf	t	(m) : 4.5 (m) : 4.5 (m) : 1.0 (m^3) : 1.4 Area (m^2) : 8.5 .n) (m) : 8.9 .n) (m) : 0.0 .n) (m) : -3.7		
	Displacement		(m^3)	: 1.447	E+4
	wetted Surfa	ce Area	a (m ⁻¹ 2)	: 8.569	E+3
	LCB (from or	igin)	(m)	: 8.918	E+T
	VCB (from or	rigin)	(m) (m)	: -3.716	正+0 E+0
	LCF (from or	iain)	(m)	9.553	E+1
	Waterplane A LCF (from or Metacentric				
	Mass		(kg)	: 1.200	E+7
	Mass/density	7	(m^3)	: 1.171	E+4
	LCG (from or	rigin)	(m)	: 9.929	E+1
	TCG (from or	rigin)	(m)	: 0.000	E+0
	VCG (from or	rigin)	(m)	: -3.947	E+0
D.	dii of Crossti	on	(m) .	0.000E+0	(roll
Ra	air or Garacio	011	(111)		
Ka	(about CG)	011	(m) :	0.000E+0	(pitcl
	Mass Mass/density LCG (from or TCG (from or VCG (from or dii of Gyratic (about CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch (yaw)
ка	(about CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch (yaw)
	(about CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch (yaw)
				0.000E+0 0.000E+0	(pitch (yaw)
	S	 TEADY 1	FORCE ANI) RESPONSE	
ка	S	 TEADY 1	FORCE ANI) RESPONSE	
Kd	S	 TEADY 1	FORCE ANI) RESPONSE	
ка		 TEADY 1	FORCE ANI	RESPONSE: 1.028: 1.996: 8.569	 E+1 E+1 E+3
ка	Ship Speed Ship Speed Wetted Surfa	 TEADY 1	FORCE ANI (m/s) (knots) a (m^2) (kN)	RESPONSE: 1.028: 1.996: 8.569	E+1 E+1 E+3 E+2
	Ship Speed Ship Speed Wetted Surfa	 TEADY 1	FORCE ANI (m/s) (knots) a (m^2)	: 1.028 : 1.996 : 8.569 : 1.833	E+1 E+1 E+3 E+2 E-4

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* *	SWAN2	2002	SOLVE		
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			GRID INFO	 RMATION	
				SSG File	
She	et# NP1	NP2	NP	KP	MP
	1 6	70 70	420	3	0
	2 17	70	420 1190	3 3	0
	3 48	16	768	2	1
	4 12	9		5	1
	5 12	9	108	5	1
	6 16 	16 	256	1	0
	 DRTNCTD		ROSTATIC	PARTICULA	 RS
density (kg/m^3) = 1025	5.000	gravity	$(m/s^2) =$	9.800
	Waterline Ler	at h	(m)	. / 13/	E+2
	Waterline Bea	am	(m)	: 4.582	E+1
	Maximum Draft		(m)	: 1.033	E+1
	Displacement		(m^3)	: 1.447	E+4
	Wetted Surface	ce Area	a (m^2)	: 8.569	E+3
	LCB (from ori	.gin)	(m)	: 8.918	E+1
	TCB (from ori	.gin)	(m)	: 0.000	E+0
	Waterline Ber Maximum Draft Displacement Wetted Surfac LCB (from ori TCB (from ori VCB (from ori				
	Waterplane An LCF (from ori Metacentric h	rea	(m^2)	: 2.593	E+3
	LCF (from or	.gin)	(m)	: 9.553	E+1
	Mass Mass/density LCG (from ori TCG (from ori VCG (from ori ii of Gyratio about CG)		(kg)	: 1.200	E+7
	Mass/density		(m^3)	: 1.171	E+4
	LCG (from ori	.gin)	(m)	: 9.929	E+1
	TCG (from or	gin)	(m)	: 0.000	E+0
	VCG (from ori	.gin)	(m)	: -3.947	E+0
Rad	ii of Gyratio	n	(m) :	0.000E+0	(roll
(about CG)		(m) :	0.000E+0	(pitch
			(111):	0.UUUE+0	(yaw)
		י עמגשי			
				RESPONSE	
	Ship Speed Ship Speed Wetted Surface		(m/s)	: 1.286	E+1
	Ship Speed		(knots)	: 2.497	E+1
	Wetted Surfac	ce Area	a (m^2)	: 8.569	E+3
	RW		(kN)	: 4.11/	E+2
	Cw			: 5.669	
	Sinkage		(m)	: 3.445 : 1.484	E+0
	Trim at CG		(deg)	: 1.484	E+0

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		Name		GRID INFO tsuR066	SSG File	
	Sheet#	NP1				MP
	1	6	70	420	3	0
	2	17	70	1190	3	0
	3	48	16	1190 768 108 108	3 2	1
	4	12	9 9	108	5	1
	5	12		108	5	1
	6	16	16	256	1	0
densi		^ 1 1 1 1 1	- 000		PARTICULA	0 000
				gravity	: 4.134 : 4.582 : 1.033 : 1.445 : 8.569 : 8.918	
	Wate:	rline Ler	ngth	(m)	: 4.134	1E+2
	Wate:	rline Bea	am	(m)	: 4.582	2E+1
	Maxi	mum Draft	ī.	(m)	: 1.033	3E+1
	Disp	Lacement	_	(m^3)	: 1.447	/E+4
	Wett	ed Surfac	ce Are	a (m^2)	: 8.569	9E+3
	LCB	(from or	ıgin)	(m)	: 8.918	3E+1
	TCB	(from or	ıgin)	(m)	: 0.000)E+0
	VCB	(Irom or	191n) 	(m)	: 8.918 : 0.000 : -3.716	 o≝+U
	Wate:	rplane Ai	rea	(m^2)	: 2.593	3E+3
	LCF	(from or:	igin)	(m)	: 9.553	3E+1
	Meta	centric h	neight	(m)	: 2.593 : 9.553 : 7.704	1E+0
	Mass	/dong: +		(KG)	: 1.200	ノロナ / I ロ・4
	Mass	/ density	: ~ : ~)	(111 3)	. 1.1/1	LD+4
	псс	(from or:	rain)	(111)	9.929	7₽+T
	TCG	(from or:	rain)	(111)	. 0.000	ノロ+U 7日・0
	Padii ce	(TION OT	ratii)	(III)	0 000000	/±+U
	Radii oi	GVraLLO	110		U.UUUE+U	(roll
	/ahan	- da)		(m)	0 0005.0	(n i + ah
	(abou	t CG)	_	(m) :	: 1.200 : 1.177 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0	(pitch
	(abou	t CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch (pitch) (yaw)
	(abou			(111) :	0.000E+0 0.000E+0	(pitch
			 геару 	FORCE ANI	D RESPONSE	
	Ship Ship	Speed Speed	 FEADY	FORCE ANI	D RESPONSE	
	Ship Ship	Speed Speed	 FEADY	FORCE ANI	D RESPONSE	
	Ship Ship	Speed Speed	 FEADY	FORCE ANI	D RESPONSE	
	Ship Ship Wett Rw Cw	Speed Speed Speed ed Surfac	 FEADY	FORCE ANI (m/s) (knots) a (m^2) (kN)	D RESPONSE : 1.543 : 2.996 : 8.565 : 4.794	 3E+1 5E+1 9E+3
	Ship Ship Wett Rw Cw	Speed Speed	 FEADY	FORCE ANI	D RESPONSE : 1.543 : 2.996 : 8.565 : 4.794	 3E+1 5E+1 9E+3 4E+2 5E-4

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*		SWAN2	2002	SOLVE		
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*****	******	******	****	******	*****	*****
				GRID INFO		
		Name	:	tsuR066	SSG File	
	Sheet#		NP2	NP	KP	MP
	1	6	70	420	3	0
	2	17	70 16	1190	3 2	0
	3 4	48 12	16	/68 100	∠ 5	1 1
	5	12	9 9	768 108 108	5	1
	6	16	16	256	1	0
		PRINCIP	 At. hyi	DROSTATIO	PARTICULA	RS
densi	tv (ka/m	^3) = 1025	5.000	gravitv	(m/s^2) =	9.800
	Wate:	rline Ler rline Bea mum Draft lacement ed Surfac	ıgth	(m)	: 4.134	
	Wate:	rline Bea	am	(m)	: 4.582	
	Maxi	mum Draft -	:	(m)	: 1.03	3E+1
	Disp.	Lacement	-	(m^3)	: 1.44	7E+4
	Wett	ed Surfac	ce Are	a (m 2)	: 8.56	JE+3 コロ・1
	TCB	(from ori	.gin)	(m)	: 8.91	3E+T
	VCB	(from ori	.gin)	(m)	: 8.918 : 0.000 : -3.716	5E+0
	Wate:	rplane Ar (from ori centric h	rea	(m^2)	: 2.593 : 9.553	3E+3
	LCF	(from ori	.gin)	(m)	: 9.55	3E+1
	Mass			(ka)	: 1.200 : 1.17: : 9.92: : 0.000 : -3.94' 0.000E+0)E+7
	Mass	/densitv		(m^3)	: 1.17	LE+4
	LCG	from ori	gin)	(m)	: 9.929	9E+1
	TCG	(from ori	gin)	(m)	: 0.000	DE+0
	VCG	(from ori	gin)	(m)	: -3.94	7E+0
	Radii of	Gyratio	n	(m) :	0.000E+0	(roll)
	(abou	t CG)		(m) :	0.000E+0	(pitch
				(m) :	0.000E+) (yaw)
				(,		-
		 	 CEADY		O RESPONSE	
				FORCE AN	D RESPONSE	
				FORCE AN	D RESPONSE)E+1
	Ship Ship	Speed Speed		FORCE ANI	D RESPONSE)E+1
	Ship Ship Wett			FORCE ANI (m/s) (knots) a (m^2)	D RESPONSE)E+1
	Ship Ship Wett Rw	Speed Speed		FORCE ANI	: 1.800 : 3.49! : 8.56:	 DE+1 5E+1 9E+3 5E+3
	Ship Ship Wett Rw Cw	Speed Speed ed Surfac		FORCE AND (m/s) (knots) a (m^2) (kN)	D RESPONSE : 1.800 : 3.499 : 8.566 : 1.056 : 7.419	DE+1 5E+1 9E+3 5E+3 9E-4
	Ship Ship Wett Rw Cw Sink	Speed Speed		FORCE ANI (m/s) (knots) a (m^2)	: 1.800 : 3.49! : 8.56:	DE+1 5E+1 9E+3 5E+3 9E-4 9E-4

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*					*
*	SWAN2 2	002	SOLVE		*
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******	*****	****	*****	*****	*****
		(GRID INFO	RMATION	
	Name	:	tsuR070	SSG File	
G1 # #					
Sheet# 1	NP1 6	NPZ Qn	NP	KP 3	MP 0
2	19	8.0	480 1520 660 98	3	0
3	55	12	660	3 2	í
4	14	7	98	5	1
5	14	7	98	5	1
6	12	12	144	1	0
	PRINCIPAL	HYD	ROSTATIC	PARTICULA	RS
density (kg/m ²					
Wate:	rline Lengt rline Beam mum Draft lacement ed Surface	:h	(m)	: 4.134	1E+2
Wate	rline Beam		(m)	: 4.586	5E+1
Maxi	mum Draft		(m)	: 1.033	3E+1
Disp	lacement		(m^3)	: 1.388	3E+4
Wette	ed Surface	Area	a (m^2)	: 8.511	LE+3
LCB	(from origi	ın)	(m)	: 9.912	2E+1
TCB	(from origi	in)	(m)	: 0.000)E+0
VCB	(from orig: (from orig: (from orig:		(111)	3.333	7E+U
Wate	rplane Area (from orig: centric he:	а	(m^2)	: 2.596	5E+3
LCF	(from orig:	in)	(m)	: 9.691	LE+1
Meta	centric he:	ight	(m)	: 8.119	9E+0
Mass	/ 2		(kg)	: 1.200)E+7
Mass,	/density	۱ ۱	(III 3)	: 1.171	LE+4
TCG	(from orig	in)	(III) (m)	. 9.925)ETU \n+T
ACG	(from origi	in)	(m)	3.947	7E+0
Radii of	/density (from orig: (from orig: (from orig: Gyration t CG)	/	(m) :	0.000E+0	(roll)
(about	t ĈĠ)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	STE	ADY I	FORCE AND	RESPONSE	
Ship	Speed		(m/s)	: 7.720)E+0
Ship	Speed Speed		(knots)	: 1.499	9E+1
Wette	ed Surface	Area	a (m^2)	: 8.511	LE+3
Rw	Speed Speed ed Surface		(kN)	: 4.265	E+2
Cw			, .	: 1.640)E-3
Sinka	age			: 6.086	
Trim	at CG		(aeg)	: -7.413	3E-2

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* Massachusetts Institute of Technology * *********************************	***
GRID INFORMATION Name : tsuR070 SSG File Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	***
GRID INFORMATION Name : tsuR070 SSG File Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	
Name : tsuR070 SSG File Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	
Name : tsuR070 SSG File Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	
Name : tsuR070 SSG File Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	
Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	
1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1	
2 19 80 1520 3 0 3 55 12 660 2 1	
3 55 12 660 2 1	
4 14 7 00 E 1	
4 14 7 98 5 1	
5 14 7 98 5 1	
6 12 12 144 1 0	
PRINCIPAL HYDROSTATIC PARTICULARS	
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.80$	١٥
Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.388E+4 Wetted Surface Area (m^2): 8.511E+3 LCR (from origin) (m): 9.912E+1	
Waterline Beam (m): 4.586E+1	
Maximum Draft (m) : 1.033E+1	
Displacement (m^3) : 1.388E+4	
Wetted Surface Area (m^2) : 8.511E+3	
LCB (from origin) (m) : 9.912E+1	
TCB (from origin) (m) : 0.000E+0	
LCB (from origin) (m): 9.912E+1 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.539E+0	
Waternlane Area (m^2) · 2 596E+3	
LCF (from origin) (m) : 9.691E+1	
Waterplane Area (m^2) : 2.596E+3 LCF (from origin) (m) : 9.691E+1 Metacentric height (m) : 8.119E+0	
Mass (kg) : 1.200E+7	
Mass/density (m^3) : 1.171E+4	
LCG (from origin) (m): 9.929E+1	
TCG (from origin) (m): 0.000E+0	
Radii of Gyration (m) · 0 000E 0 (rol	٦)
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (rol (about CG) (m) : 0.000E+0 (pitc) (m) : 0.000E+0 (vol	+ <i>1</i>
(m) : 0.000E+0 (yav	,11, ,)
(m) (
AMPT-11	
STEADY FORCE AND RESPONSE	
Ship Speed (m/s) : 1.028E+1	
Shin Speed (knots) · 1 996F±1	
Wetted Surface Area (m^2): 8.511E+3 Rw (kN): 8.151E+2	
Rw (kN): 8.151E+2	
Cw : 1.768E-3	
Sinkage (m): 4.785E-1	
Sinkage (m) : $4.785E-1$ Trim at CG (deg) : $-1.131E-1$	

		SWAN2	2002	SOLVE		
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*****	******	****	*****	*****	******	*****
				GRID INFO		
					SSG File	
	Sheet#	ND1	ND2	ND	KP 3 3 2 5	MP
	1	6	80	480	3	0
	2	19	80	1520	3	0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
		PRINCIP	 AL HYF	ROSTATIC	PARTICULAR	RS
densi	ty (kg/m	^3) = 1025	.000	gravity	$(m/s^2) =$	9.80
	Mato	rlino Ion	a+h	(m)	. / 12/	E+2
	Wate:	rline Bea	ım	(m)	: 4.586	E+1
	Maxi	mum Draft	;	(m)	: 1.033	E+1
	Disp	lacement		(m^3)	: 1.388	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.511	E+3
	LCB	(from ori	ain)	(m)	: 9.912	E+1
	TCB	(from ori	.gin)	(m)	: 0.000	E+0
	VCB	(from ori	gin)	(m)	: 4.586 : 1.033 : 1.388 : 8.511 : 9.912 : 0.000 : -3.539	E+0
	T-7-4			(^o)		
	wate:	rpiane Ar	rea 、	(m 2)	: 2.596 : 9.691	E+3
	LCF.	(Irom ori	.gin)	(m)	: 9.691	E+T
	Meta	rplane Ar (from ori centric h	neight	(m)	: 8.119	E+0
	Mass			(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+7
	Mass	/densitv		(m^3)	: 1.171	E+4
	LCG	(from ori	ain)	(m)	9.929	E+1
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	E+0
	Radii of	Gyratio	n	(m) ·	0.000E+0	(roll
	(about	t (G)		(m) ·	0.000E+0	(pitc
	(,		(m) :	0.000E+0	(vaw
		ST	EADY	FORCE AND	RESPONSE	
	Ship	Speed		(m/s)	: 1.286	E+1
	Ship	Speed		(knots)	: 2.497	E+1
	Wett	ed Surfac	e Are	a (m^2)	: 8.511	E+3
				(1-37)	2 060	П. О
	Rw			(KN)	: 3.962	E+2
	Rw Cw			(KN)	: 3.962	E+∠ E-4
	Rw Cw Sinka	age		(KN)	: 1.286 : 2.497 : 8.511 : 3.962 : 5.493 : 1.214 : 2.509	E+2 E-4 E+0

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*	Massa			(C) 2002 itute of	: Technology	
*						
*****	******	******	****	******	*****	*****
				GRID INF		
		Name	:	tsuR070	SSG File	
	Sheet#	NP1	NP2	NP	KP	MP
	1	6	80	480 1520 660 98	3 3 2	0
	2	19	80	1520	3	0
	3 4	55 14	12	660	∠ 5	1 1
	5	14 14	7	98 98	5 5	1
	6	12	12	144	1	0
			יאד. שעי	 ⊃₽∩⊆Ͳ⊼ͲΤ <i>ℂ</i>	PARTICULA	PC
donai	+17 (lea /m)	PKINCIP	AT HII	JRUSTATIC	(m/s^2) =	0 0 0 0
uensi	су (ку/ш 	3)= 1023		gravity	(111/8 2)=	9.600
	Wate:	rline Ler	ngth	(m) (m) (m) (m^3) a (m^2)	: 4.13	4E+2
	Wate:	rline Bea	am	(m)	: 4.58	
	Maxi	mum Draft	t.	(m)	: 1.03	D . 1
	Disp	lacement		(m^3)	: 1.38	3E+4
	Wett	ed Surfac	ce Are	a (m^2)	: 8.51	1E+3
	LCB	(from or:	igin)	(m)	: 9.91	2E+1
	TCB	(from or:	igin)	(m)	: 0.00	0E+0
	VCB	(from or:	igin)	(m)	: 9.91 : 0.00 : -3.53	9E+0
	Wate	rplane A	rea	(m^2)	2.59	
	LCF	(from or	igin)	(m)	: 2.59 : 9.69	1E+1
	Meta	centric h	neight	(m^2) (m) (m)	: 8.11	9E+0
	Mass	/donait.		(Kg)	: 1.20 : 1.17 : 9.92 : 0.00 : -3.94 0.000E+0	JE+/
	Mass,	/delisity	iain	(III 3)	. 0.02	1E+4
	TCG	(from or	igin)	(III) (m)	. 9.94	JE+U JE+T
	VCG	(from or	igin)	(m)	3 94	7E+0
	Radii of	Gyratio	n	(m) ·	0 000E+0	(roll)
	madii oi	+ CC)		(m) .	0.000E+0	(pitch
	(aboii					
	(abou	L CG)		(m) :	0.000E+	(yaw)
	(abou ⁻			(m) :	0.000E+	(yaw)
	(abou			(m) :	0.000E+	(yaw)
	(abou:			(m) :	0.000E+	(yaw)
	(abou:			(m) :	0.000E+	(yaw)
	(abou			(111) :	0.000E+	(yaw)
		S	 FEADY	FORCE AN	D RESPONSE	
		S	 FEADY	FORCE AN	D RESPONSE	 3E+1
	Ship Ship	Speed Speed	 FEADY	FORCE AN: (m/s) (knots)	D RESPONSE	 3E+1 6E+1
	Ship Ship Wett	Speed Speed	 FEADY	FORCE AN: (m/s) (knots) a (m^2)	D RESPONSE : 1.54 : 2.99 : 8.51	3 3E+1 5E+1 1E+3
	Ship Ship Wett Rw	Speed Speed	 FEADY	FORCE AN: (m/s) (knots)	D RESPONSE : 1.54 : 2.99 : 8.51 : 1.48	3 3E+1 5E+1 1E+3 9E+3
	Ship Ship Wett Rw Cw	Speed Speed Speed ed Surfac	 FEADY	FORCE AN (m/s) (knots) a (m^2) (kN)	D RESPONSE : 1.54 : 2.99 : 8.51 : 1.48 : 1.43	 3E+1 5E+1 1E+3 9E+3 4E-3
	Ship Ship Wett Rw Cw Sink	Speed Speed	 FEADY	FORCE AN: (m/s) (knots) a (m^2)	D RESPONSE : 1.54 : 2.99 : 8.51 : 1.48	3 3E+1 5E+1 1E+3 9E+3 4E-3 5E+0

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		SWAN2	2002	SOLVE		
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				GRID INFO	 NPM∆TT∩N	
			:	tsuR070	SSG File	
	Sheet#	NP1	NP2	NP	KP	MP
	1	6	80	480	3	0
	2	19	80	NP 480 1520	3 3 2	0
	3	55	12	880	∠	1
	4	14	7		5	1
	5	14	7	98	5	1
	6 	12	12 	144	1 	0
		PRINCIPA	AL HYD	ROSTATIC	PARTICULAR	RS
densi	ty (kg/m	^ 3)= 1025	.000	gravity	(m/s^2) =	9.800
	Wate	rline Len	a+h	(m)	. / 13/	E+2
	Wate:	rline Bea	.m	(m)	: 4.586	E+1
	Maxi	mum Draft		(m)	: 1.033	E+1
	Disp	lacement		(m^3)	: 1.388	E+4
	Wett	ed Surfac	e Area	a (m^2)	: 8.511	E+3
	LCB	(from ori	gin)	(m)	: 9.912	E+1
	TCB	(from ori	gin)	(m)	4.586 : 1.033 : 1.388 : 8.511 : 9.912 : 0.000 : -3.539	E+0
	Wate:	rplane Ar	ea	(m^2)	: 2.596 : 9.691 : 8.119	E+3
	LCF	(from ori	gin)	(m)	: 9.691	E+1
	Mass			(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 9.929	E+1
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	E+0
	Radii of	Gyration	า	(m) :	0.000E+0	(roll
	(abou	t CG)		(m) :	0.000E+0	(pitch
				(m) :	0.000E+0	(yaw)
					RESPONSE	
	Ship	Speed		(m/s)	: 1.800	E+1
	Ship	Speed		(knots)	: 3.495	E+1
	Mott	ed Surfac	e Area	a (m^2)	: 8.511	E+3
	WELL					
	Rw			(kN)	: 3.205	E+3
	Rw Cw			(kN)	: 3.205 : 2.268	E+3 E-3
		age at CG		(kN) (m) (deg)	: 1.800 : 3.495 : 8.511 : 3.205 : 2.268 : 2.568 : 1.169	E+3 E-3 E+0

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	SWAN2	2002	SOLVE		
	Соруг	right	(C) 2002		
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			GRID INFO	RMATION	
				SSG File	
Chaat	# NP1	MDO	MD	KP	MP
1	6	80	480	3	0
	19	80	NP 480 1520	3	0
3		12	880	3 3 2	1
4		7	98	5	1
5		7	98	5	1
6	12	12	144	1	0
	PRINCIPA	T HAL	ROSTATIC	PARTICULAR	ls.
density (kg	g/m^3)= 1025	.000	gravity	$(m/s^2) =$	9.800
Wa	aterline Len	gth 	(m)	: 4.1341	E+2
Wa Ma	aceriine Bea Sylmim Droft	III	(m)	: 4.586	达+1 F±1
. ل المار	isnlacement		(m^3)	. 1 3881	⊔+⊥ E+4
W.	etted Surfac	e Are	a (m^2)	: 8.5111	E+3
L	CB (from ori	gin)	(m)	: 1.125	E+2
T	CB (from ori	gin)	(m)	: 0.0001	E+0
Ac	aterline Bea aximum Draft isplacement etted Surfac CB (from ori CB (from ori	gin)	(m)	: -3.539	E+0
W c	aterplane Ar CF (from ori etacentric h	ca ain)	(III ∠) (m)	. 4.596	±+3 R±1
Me	etacentric h	eiaht	(m)	: 8.119	E+0
Ma	ass ass/density CG (from ori CG (from ori CG (from ori of Gyration		(kg)	: 1.200	E+7
Ma	ass/density		(m^3)	: 1.171	E+4
L	CG (from ori	gin)	(m)	: 9.9291	E+1
.T.(CG (from ori	gin)	(m)	. 0.000	E+0
VV Padii	of Gyration of Liou orl	л Атп)	(III)	3.94/	_+∪ (roll
Raull (a)	out CG)	1	(m) :	0.000E+0	(pitch
(4)			(m) :	0.000E+0	(yaw)
	QT	EADY	FORCE AND	RESPONSE	
Sl	nip Speed nip Speed etted Surfac W		(m/s)	: 7.720	E+0
Sl	nip Speed		(knots)	: 1.499	E+1
We	etted Surfac	e Are	a (m^2)	: 8.511	E+3
Rı	Ň		(kN)	: 2.749	E+2
CI	N			: 1.058	변-3
	inkage		(m)	: -2.8691 : -2.0691	반+U E · O
Ti	rim at CG		(deg)	: -2.069	Ľ+U

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	SWAN2	2002	SOLVE		
	Сору	right	(C) 2002		
Mass	achusetts	Insti	tute of	Technology	
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		(GRID INFO	ORMATION	
				SSG File	
Sheet#	NP1	NP2	NP	KP	MP
1 2	6 19	80	NP 480 1520	3 3 2	0
3	19 55	12	660	3	1
3 4	14	7		5	1
5	14	7	98 98	5	1
6			144	1	0
	PRINCIP.	AL HYD	ROSTATIC	PARTICULA	RS
density (kg/r	n^3)= 1025	5.000	gravity	$(m/s^2) =$	9.800
	 vrlino Tor				
Wate	erline Ler	ıgtn	(m)	: 4.134	西+2 〒-1
Wate	*TITHE RES	۱۱۱۱ - -	(m)	: 4.586	D+1 D±1
Max.	u Diall	-	(m^3)	. 1.033	F-4
M=++ DIS	ed Surfac	e Are	(m^2)	. 1.300	E+3
T.CB	from ori	iain)	/ (III Z) /m)	. 1 125	E+2
TCR	(from ori	iain)	(m)	. 0.000	E+0
VCB	(from ori	lgin)	(m)	: 4.586 : 1.033 : 1.388 : 8.511 : 1.125 : 0.000	E+0
Wate	erplane Ar	rea	(m^2)	: 2.596 : 9.997 : 8.119	E+3
LCF	(from ori	igin)	(m)	: 9.997	E+1
Meta	acentric h	neight	(m)	: 8.119	E+0
Mass	. / -1		(kg)	: 1.200	L+7
Mass	/aensity		(m 3)	: 1.171	上十4
LCG	(from ori	igin)	(m)	: 9.929	E - V
TCG	(from ori	igin)	(III) (m)	2 0/7	.Ε.Τ.Ο .Ε.+.Ω
VCG Padii o	f Gyratio	n n	(m) ·	0 000110	(roll
(ahoi	r Gyracio. it CG)		(m) ·	0.000E+0	(pitcl
) Odb)	,		(m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	(yaw)
	SI	TEADY :	FORCE ANI	RESPONSE	
Shir	Speed		(m/s)	: 1.028 : 1.996 : 8.511 : 2.488 : 5.398 : -2.152	E+1
Shir	Speed	_	(knots)	: 1.996	E+1
Wett	ed Surfac	ce Are	a (m ⁻¹ 2)	: 8.511	E+3
Rw G			(KN)	: 2.488	E+2
CW Cd-m1			(m)	: 5.398	E-4
					E+U
Trir	n at CG		(deg)	: -1.705	上+U

Name : t Sheet# NP1 NP2 1 6 80	C) 2002 ute of ' ****** ID INFC	**************************************
Massachusetts Institute * ********************************	ute of ' ****** ID INFO	**************************************
Massachusetts Institu ************************************	ute of ' ****** ID INFO	**************************************
************************************	****** ID INFO	**************************************
GR Name : t	ID INFO	ORMATION
Name : t	suR071	
Name : t	suR071	
Name : t	suR071	
		CCC HILD
Sheet# NP1 NP2 1 6 80		
1 6 80	NP	KP MP
	480	3 0
2 19 80	1520	3 0 3 0 2 1
$egin{array}{cccccccccccccccccccccccccccccccccccc$	660	2 1 5 1
5 14 7	98 98	5 1
6 12 12		1 0
PRINCIPAL HYDRO	DSTATIC	PARTICULARS
density $(kg/m^3) = 1025.000 g$	ravity	(m/s 2) = 9.800
Waterline Length	(m)	· / 13/E+2
Waterline Beam	(m)	: 4.586E+1
Waterline Beam Maximum Draft Displacement Wetted Surface Area LCB (from origin) TCB (from origin) VCB (from origin)	(m)	: 1.033E+1
Displacement	(m^3)	: 1.388E+4
Wetted Surface Area	(m^2)	: 8.511E+3
LCB (from origin)	(m)	: 1.125E+2
TCB (from origin)	(m)	: 0.000E+0
VCB (from origin)	(111)	: -3.539E+U
Waterplane Area	(m^2)	: 2.596E+3
Waterplane Area LCF (from origin) Metacentric height	(m)	: 9.997E+1
Metacentric height	(m)	: 8.119E+0
Mass /dongity	(Kg)	: 1.200E+7
I.CG (from origin)	(m)	. 1.1/15+4 . 9 929F1
TCG (from origin)	(m)	: 0.000E+0
VCG (from origin)	(m)	: -3.947E+0
Radii of Gyration (m	n) :	0.000E+0 (roll
(about CG) (m	.) :	0.000E+0 (pitch
(m) :	0.000E+0 (yaw)
(1		
Mass Mass/density LCG (from origin) TCG (from origin) VCG (from origin) Radii of Gyration (m (about CG) (m		
(9		
(**************************************		
(**		
		RESPONSE
STEADY FO	 RCE AND) RESPONSE
STEADY FO	 RCE AND) RESPONSE
STEADY FO	 RCE AND) RESPONSE
STEADY FO Ship Speed Ship Speed (k: Wetted Surface Area	RCE AND (m/s) nots) (m^2)	D RESPONSE : 1.286E+1 : 2.497E+1 : 8.511E+3
STEADY FO Ship Speed Ship Speed (k: Wetted Surface Area Rw	RCE AND (m/s) nots) (m^2)	: 1.286E+1 : 2.497E+1 : 8.511E+3 : 6.897E+2
STEADY FO Ship Speed Ship Speed (k: Wetted Surface Area Rw Cw	RCE AND (m/s) nots) (m^2)	D RESPONSE : 1.286E+1 : 2.497E+1 : 8.511E+3

	MP 0 0 1 1 1
* Massachusetts Institute of Technology * **********************************	MP 0 0 1 1 1
* Massachusetts Institute of Technology * **********************************	MP 0 0 1 1 1
* ***********************************	MP 0 0 1 1 1
GRID INFORMATION Name : tsuR071 SSG File Sheet# NP1 NP2 NP KP 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	MP 0 0 1 1 1
Name : tsuR071 SSG File Sheet# NP1 NP2 NP KP 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	0 0 1 1 1 0
Sheet# NP1 NP2 NP KP 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	0 0 1 1 1 0
1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	0 0 1 1 1 0
2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	0 1 1 0
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	1 1 0
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	1 1 0
5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	0
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9	
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9$	
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9$	
Waterline Length (m): 4.134E+ Waterline Beam (m): 4.586E+ Maximum Draft (m): 1.033E+ Displacement (m^3): 1.388E+ Wetted Surface Area (m^2): 8.511E+ LCB (from origin) (m): 1.32E+	
Waterline Beam (m): 4.586E+ Maximum Draft (m): 1.033E+ Displacement (m^3): 1.388E+ Wetted Surface Area (m^2): 8.511E+	2
Maximum Draft (m): 1.033E+ Displacement (m^3): 1.388E+ Wetted Surface Area (m^2): 8.511E+	1
Displacement (m 3): 1.388E+ Wetted Surface Area (m^2): 8.511E+ LCR (from origin) (m): 1.32E+	1
TCR (from origin) (m) . 1 125E.	4
	<i>3</i>
TCB (from origin) (m) : 0.000E+	0
VCB (from origin) (m) : -3.539E+	0
Waterplane Area (m^2): 2.596E+ LCF (from origin) (m): 9.997E+ Metacentric height (m): 8.119E+	
LCF (from origin) (m) : 9.997E+	1
Mass (kg) : 1.200E+ Mass/density (m^3) : 1.171E+ LCG (from origin) (m) : 9.929E+ TCG (from origin) (m) : 0.000E+ VCG (from origin) (m) : -3.947E+ Radii of Gyration (m) : 0.000E+0 (r (about CG) (m) : 0.000E+0 (p (m) : 0.000E+0 (r	7
Mass/density (m ³): 1.171E+	4
LCG (irom origin) (m): 9.929E+	T
VCG (from origin) (m) · -2 947F1	0
Radii of Gyration (m) : 0.000E+0 (r	011
(about CG) (m) : 0.000E+0 (p	itch
(m) : 0.000E+0 (yaw)
OMBADY BODGE AND DECOME	
STEADY FORCE AND RESPONSE	
	·
Ship Speed (m/s) : 1.543E+	 1
Ship Speed (m/s): 1.543E+ Ship Speed (knots): 2.996E+	
Ship Speed (m/s) : 1.543E+ Ship Speed (knots) : 2.996E+ Wetted Surface Area (m^2) : 8.511E+	1 1 3
Ship Speed (m/s): 1.543E+ Ship Speed (knots): 2.996E+ Wetted Surface Area (m^2): 8.511E+ Rw (kN): 8.327E+	 1 1 3 2
Ship Speed (knots) : 2.996E+ Wetted Surface Area (m^2) : 8.511E+	

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	37		GRID INFO		
	Name	:	tsuk0/1	SSG File	
Sheet#	NP1	NP2	NP	KP	MP
1	6	0 0	400	2	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	98	5	1
5	14	7	98	5	1
6	12	12	144	1	0
				PARTICULA	
density (kg/m'	3)= 1025	5.000	gravity	$(m/s^2) =$	9.800
Water	cline Ler	ıgth	(m) (m) (m) (m^3) a (m^2)	: 4.134	
Watei	rline Bea	am -	(m)	: 4.586 : 1.033	
Maxii	num Diait	-	(m^3)	1 3 2 9	
Wette	ed Surfac	ce Are	a (m^2)	: 1.388 : 8.51	LE+3
LCB	(from ori	lgin)	(m)	: 1.12	5E+2
TCB	(from ori	igin)	(m)	: 1.12! : 0.000 : -3.53!	DE+0
VCB	(from ori	lgin)	(m)	: -3.539	9E+0
			·		
Water	rpiane Ai	rea	(m 2)	: 2.590 : 9.99' : 8.119	o≝+3 7⊡.1
Metad	centric h	neiaht	(m)	8.11	9E+0
Mass			(kg)	: 1.20	DE+7
Mass	density/		(m^3)	: 1.17	LE+4
LCG	(from ori	lgin)	(m)	: 9.92	9E+1
TCG	(Irom ori	lgin)	(m)	: 1.200 : 1.17: : 9.92: : 0.000 : -3.94' 0.000E+0	JĽ+0 7団・0
VCG Padii of	(Irom orl	rgin)	(III)	-3.94	/E+U /xoll\
(about	GYTALIO - CG)	11	(III) :	0.000E+0	(nitch)
(about	2 667		(m) :	0.000E+	(vaw)
	C T		EOBCE VVII	RESPONSE	
	اد	 	OKCE AM	· VESTONSE	
Ship	Speed		(m/s)	: 1.80)E+1
Ship	Speed Speed		(knots)	. 3 491	5F±1
Wette	ed Surfac	ce Are	a (m^2)	: 8.513 : 1.150	LE+3
Rw				: 1.150	DE+3
Cw			, ,	: 8.13	D比-4
Sinka	age		(m) (deg)	: -5.043	
Trim	at CG		(ueg)	: -2.70	> ⊏ + U
				·	

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				GRID INFO		
		Name		tsuR078	SSG File	
	Sheet.#	NP1 6 19 55 14	NP2	NP	KP	MP
	1	6	80	480	3	0
	2	19	80	1520	3 3 2	0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
		DRINCID:	 Δт. шуг	ROSTATTC	₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽₽	 25
dencit	-v (ka/m	^3) = 1025	יים עזו	aravity	PARTICULAR (m/s^2) =	9 8 U
		3)= 1023		9-4416	, b 2) =	٠.٠٠-
	Wate	rline Len	ıgth	(m)	: 4.134 : 4.421 : 1.033 : 1.334 : 8.542 : 9.659 : 0.000 : -3.536	E+2
	Wate	rline Bea	ım	(m)	: 4.421	E+1
	Maxi	mum Draft		(m)	: 1.033	E+1
	Disp	lacement		(m^3)	: 1.334	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.542	E+3
	LCB	(from ori	gin)	(m)	: 9.659	E+1
	TCB	(from ori	gin)	(m)	: 0.000	E+0
	VCB	(from ori	gin)	(m)	: -3.536	E+0
	Wata	rnlano Ar		(m^2)	. 2 520	
	T.CF	(from ori	ain)	(III Z)	. 2.320	E-1
	Meta	centric h	gin)	(III)	: 2.520 : 9.832 : 5.666	E-U
	Mass			(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 9.929	E+1
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	E+0
	Radii of	Gyration	n	(m) :	0.000E+0	(roll
	(abou	t CG)		(m) :	0.000E+0	(pitc
				(m) :	: -3.947 0.000E+0 0.000E+0 0.000E+0	(yaw
					RESPONSE	
	Shin	Speed		(m/a)	. 7720	F+0
	Shir	Speed		(knota)	. 1./20	±+∪ ₽±1
	PIITD	od grafer	0 7	(VIIOCE)	. 1.499	D + 3 □+1
	well	eu suriac	e Are	a. (III ∠) /1-NT)	: 7.720 : 1.499 : 8.542 : 5.625 : 2.156	E+3
	ĸw			(KIN)	: 5.625	□ 1 □ 1
	C7.7					
	Cw	200		/m\	. 2.156	E-4
	Sink	age at CG		(m)	: 2.156 : 1.271 : 4.040	E+0

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	Name	:	GRID INFO	RMATION SSG File	
	 ee+# ND1	MDO			MP
511	eet# NP1 1 6	80	480 1520 660	3	0
	2 19	80	1520	3	0
		12	660	2 5	1
	4 14 5 14		98 98	5 5	1 1
	6 12			1	0
	PRINC	TPAL HY	DROSTATIC	PARTICULAR	 S
density	$(kg/m^3) = 10$	025.000	gravity	$(m/s^2) =$	9.800
	Waterline 1	Length	(m)	: 4.134E : 4.421E : 1.033E : 1.334E : 8.542E : 9.659E : 0.000E : -3.536E	E+2
	Waterline I	Beam	(m)	: 4.421E	3+1
	Displacement	dil nt	(III) (m^3)	: 1.033E	5+1 7±4
	Wetted Sur	face Are	a (m^2)	: 8.542E	3+ 3 3+3
	LCB (from o	origin)	(m)	: 9.659E	E+1
	TCB (from o	origin)	(m)	: 0.000E	E+0
	Waterplane	Area	(m^2)	: 2.520E	E+3
	Metacentri	origin) c height	(m) (m)	: 2.520E : 9.832E : 5.666E	5+1 5+0
	Mass/densit	- 17	(KG) (m^3)	: 1.200E	5+ / 7+4
	LCG (from o	origin)	(m)	: 9.929E	E+1
	TCG (from o	origin)	(m)	: 0.000E	E+0
_	VCG (from o	origin)	(m)	: -3.947E	E+0
Ra	all of Gyrat	ion	(m) :	0.000E+0	(roll)
	Mass Mass/densit LCG (from of TCG (from of VCG (from of dii of Gyrat (about CG)		(m) :	0.000E+0	(yaw)
		STEADY	FORCE AND	RESPONSE	
-	Ship Speed	-	(m/s)	: 1.028E	3+1
	Ship Speed	c -	(knots)	: 1.996E : 8.542E	3+1
	Wetted Sur	tace Are	ea (m^2) (kN)	: 8.542E : 1.581E	5+3 7 - 1
	RW CW		(KIN)	: 1.581E	
	Sinkage		(m)	: 1.664E	
	Trim at CG		(deg)	: 6.184E	E-1

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******	******	****	****	*****	*****
			GRID INFO	RMATION	
	Name	:	tsuR078	SSG File	
Sheet#	ND1	NDO	NP	KP	
Sneet#	NP1 6	NP2	480	3	MP 0
2	19	80	480 1520 660 98	3	0
3	55	12	660	3 2	1
4	14	7	98	5	1
5	14	7	98	5	1
6	12	12	144	1	0
	PRINCIPA	T HAL	ROSTATIC	PARTICULA	RS
density (kg/m					
Wate	rline Len	gth	(m)	: 4.134 : 4.421 : 1.033 : 1.334 : 8.542	1E+2
Wate	rline Bea	m	(m)	: 4.42	LE+1
Maxi	mum Draft		(m)	: 1.033	3E+1
Disp	lacement	_	(m^3)	: 1.334	1E+4
Wett	ed Surfac	e Are	a (m^2)	: 8.542	2E+3
LCB	(from original	gin)	(m)	: 9.65	3E+T
VCB	(from original	gin)	(III) (m)	: 0.000	7E+0
VCB		9		: 9.659 : 0.000 : -3.536	
Wate	rplane Ar	ea	(m^2)	: 2.520	DE+3
LCF	(from original	gin)	(m)	: 9.832	2E+1
Meta	centric h	eight	(m)	: 2.520 : 9.832 : 5.666	5E+0
Mass	/dona; +		(Kg)	: 1.200	JE+7
Mass	/ delisity /from ori:	rin)	(III 3) /m)	. 1.1/.	L⊡+4 OD⊥1
TCG TCG	(from original	ain)	(III) (m)	. 9.343)E+0
VCG	(from original	gin)	(m)	: -3.94	7E+0
Radii of	Gyration	,, ا	(m) :	: 1.200 : 1.173 : 9.929 : 0.000 : -3.94 0.000E+0 0.000E+0	(roll)
(abou	t ĆG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0) (yaw)
	ਟਾਜਾ	EVDV	FORCE AND	RESPONSE	
			ANL		
Ship	Speed		(m/s)	: 1.286	5E+1
Ship	Speed Speed		(knots)	: 2.49	
Wett	ed Surfac	e Are	a (m^2)	: 8.542	2E+3
Rw				: 3.542	2E+2
Cw				: 4.892	
Sink	age			: 1.069	
Trim	at CG		(deg)	: 3.940	DE-1

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			GRID INFO		
				SSG File	
Sheet#	NP1			KP	MP
1	6	80	NP 480 1520	3	0
2	19	80	1520	3 3 2	0
3	55	12	660	2	1
4	14	7	98 98	5	1
5 6	14	7		5 1	1
6		⊥∠	144		0
	PRINCIP	AL HYD	ROSTATIC	PARTICULA	RS
density (kg/	m^3)= 1025	.000	gravity	$(m/s^2) =$	9.800
₩ > +	erline Ler	at h	(m)	. / 13/	E+2
Wat Wat	erline Bea	ım ıarı	(m)	. 4.421	E+1
Max	imum Draft	;	(m)	: 1.033	E+1
Dis	placement		(m^3)	: 1.334	E+4
Wet	ted Surfac	e Area	a (m^2)	: 8.542	E+3
LCB	(from ori	gin)	(m)	: 9.659	E+1
TCB	(from ori	.gin)	(m)	: 0.000	E+0
VCB	(from ori	.gın)	(m)	: 4.421 : 1.033 : 1.334 : 8.542 : 9.659 : 0.000	E+0
LCF	(from ori	.gin)	(m)	: 9.832	E+1
Met	acentric h	eight	(m)	: 2.520 : 9.832 : 5.666	E+0
Mas	s /1		(kg)	: 1.200	E+7
Mas	s/density	\	(m '3)	: 1.171	上十4
LCG	(from ori	.gin)	(M) (m)	. 9.929	ETU .E+T
VCG	(from ori	gin)	(m)	3.947	E+0
Radii	of Gyratio	n	(m) :	0.000E+0	(roll
(abo	ut CG)		(m) :	0.000E+0	(pitch
	-		(m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	(yaw)
	SI	EADY	FORCE AND	RESPONSE	
Shi	p Speed		(m/s)	: 1.543 : 2.996 : 8.542	E+1
Shi	p Speed		(knots)	: 2.996	E+1
Wet	ted Surfac	e Area	a (m^2)	: 8.542	E+3
K.W			(kN)	: 4.910	E+2
Cw	kage		(m)	: 4.711 : 2.874	
			(dea)	: 2.874 : 1.344	E+0
Tri	m at CG		(deg)	: 1.344	正 +∪

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*******	******	****	*****	*****	*****
			GRID INFO		
	Name	:	tsuR078	SSG File	
Sheet		NP2	NP	KP	MP
1		80	480 1520 660 98	3 3 2	0
2		80	1520	3	0
3		12	660	2	1
4		7	98 98	5 5	1 1
5		1 2	144	1	0
	, 12				
don-1 /1-	PKINCIPA	тт наг	KUSTATIC	PARTICULA	KS CAA
	g/m^3)= 1025	.000	gravity	(m/s 2)=	9.800
W	aterline Lengaterline Bear aximum Draft isplacement etted Surface	ath	(m)	: 4.134	1E+2
W	aterline Beai	m	(m)	: 4.421	LE+1
M	aximum Draft		(m)	: 1.033	3E+1
D	isplacement		(m^3)	: 1.334 : 8.542	1E+4
W	etted Surfac	e Are	a (m^2)	: 8.542	2E+3
L	CB (from original	gin)	(m)	: 9.659	9E+1
T	CB (from ori	gin)	(m)	: 0.000	DE+0
V	CB (from original control cont	gin)	(m)	: -3.536	5E+0
ти	aternlane Ar		(m^2)	. 2 520	
T.	CE (from orig	ca rin)	(III Z) (m)	: 2.520 : 9.832)F-1
M	aterplane Are CF (from origetacentric he	eiaht	(m)	: 5.666	5E+0
M	ass		(kg)	: 1.200)E+7
M	ass/density		(m^3)	: 1.171	LE+4
L	CG (from orig	gin)	(m)	: 9.929	9E+1
T	CG (from ori	gin)	(m)	: 0.000)E+0
V	ass ass/density CG (from ori CG (from ori CG (from ori CG (from ori of Gyration bout CG)	gin)	(m)	: -3.947	7E+0
Radii	. of Gyration	1	(m) :	0.000E+0	(roll)
(a)	bout CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0) (yaw)
	ST	EADY	FORCE AND	RESPONSE	
S.	hip Speed hip Speed		(m/s)	: 1.800	
S.	hip Speed		(knots)	: 3.495	5E+1
	etted Surfac	e Are	a (m^2)	: 8.542	2E+3
R			(kN)	: 9.108	3E+2
C	W			: 6.421	
S	inkage		(m) (deg)	: 3.924	
Ψ.	rim at CG				
-	IIII ac co		(aeg)	: 1.975	oE+0

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	riasso	chusects	IIISCI	.cute OI	recimorogy	
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				GRID INFO	 RMATTON	
		Name			SSG File	
	Sheet#	NP1	NP2	NP 400	KP 3 3 2 5	MP
	J	10	80	4 8 U	3 n	0
	2	T.2	80	1520	3	0
	.5 .4	55 1 4	12	000	∠ -	1
	4	14	/	98	5	1
	5 6	14 10	10	98 144	5 1	1
	ь 			144		
, ,	. /1 /				PARTICULAR	
densi	ty (kg/m	^3)= 1025	.000	gravity	(m/s^2) =	9.80
	7.7 - 4		1	/ \	4 104	E+2
	Wate	rline Bea	m	(m)	4 421	E+1
	Maxi	mum Draft		(m)	1.033	E+1
	Disp	lacement		(m^3)	. 1 334	E+4
	Wett	ed Surfac	e Are	a (m^2)	. 8 542	E+3
	LCB	(from ori	ain)	(m)	. 1 018	E+2
	TCB	(from ori	ain)	(m)	. 0.000	E+0
	VCB	(from ori	gin)	(m)	: 4.134 : 4.421 : 1.033 : 1.334 : 8.542 : 1.018 : 0.000 : -3.536	E+0
	Wate	rplane Ar	ea	(m^2)	: 2.520	E+3
	LCF	(from ori	gin)	(m)	: 9.882	E+1
					: 2.520 : 9.882 : 5.666	
	Magg			(ka)	. 1 200	 F ₊ 7
	масс Масс	/density		(m^3)	. 1.200	E+4
	T.CC	(from ori	air)	(m)	. 0 020	R-1
	TCG	(from ori	gin)	(III) (m)	. 9.929	E T U
	ACG	(from ori	gin)	(m)	3 947	E+0
	Padii of	Cyratio		(m) ·	0 00000	(roll
	(ahou	- Gylacioi + CG)	.1	(m) ·	0.0005+0	(nitc
	(aboa	c ca,		(m) ·	0.00010	(vaw
	(abou	t CG)		(m) : (m) :	0.000E+0 0.000E+0	(pit (ya
	(abou	t CG)		(m) : (m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	(pit (ya
		ST	'EADY	FORCE ANI	RESPONSE : 7.720 : 1.499 : 8.542 : 5.414 : 2.075 : -7.795	
		On a c - 3		/ / \		
	Ship	speed		(m/s)	: 7.720	E+0
	Ship	Speed	_	(knots)	: 1.499	E+1
	Wett	ed Surfac	e Are	a (m^2)	: 8.542	E+3
	Rw			(kN)	: 5.414	E+1
	Cw				: 2.075	E-4
		age at CG		(m) (deg)	: -7.795 : -3.772	

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*	SWAN	2 2002	SOLVE		*
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*********	*****	*****	****	*****	*****
		(GRID INFO	RMATION	
	Name	:	tsuR079	SSG File	
Shee	t# NP1	NP2	NP	KP	MP
	1 6 2 19	80	480 1520 660	3 3 2 5	0
	2 19 3 55	12	1520 660	3	1
	4 14	7	98	5	1
	5 14	7	98 98	5	1
1	6 12	12		1	0
	$(g/m^3) = 102$	25.000	gravity		9.800
	Jaterline Le	ngth	(m)	: 4.134F	Ξ+2
M	Materline Be	eam	(m)	: 4.421H	Ξ+1
M	Maximum Draf	t	(m)	: 1.033E	∃+1
I to	isplacement	7	(m^3)	: 1.3341	3+4
V T	CB (from or	ice Area	a (m 2) (m)	: 8.542E	±+3 7±2
T	CB (from or	igin)	(m)	: 0.000F	∃+0
V	Jaterline Legaterline Belaximum Draf Jisplacement Jisplacement Jetted Surfa JCB (from or JCB (from or JCB (from or	rigin)	(m)	: -3.536E	Ξ +0
W	aterplane A	rea	(m^2)	: 2.520F	 E+3
I	CF (from or	rigin)	(m)	: 9.8821	3+1
	Waterplane P NCF (from or Metacentric				
	lass lass/density LCG (from or LCG)		(kg)	: 1.200	 ∑+7
M	Mass/density	7	(m^3)	: 1.171E	E +4
I	CG (from or	rigin)	(m)	: 9.9291	Ξ+1
7.	CG (from or	rigin)	(m) (m)	3 9471	5+0 7+0
Radi	i of Gvrati	on	(m) :	0.000E+0	(roll)
(a	bout CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	٤	STEADY 1	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.028E	 ∃+1
S	Ship Speed		(knots)	: 1.028F : 1.996F : 8.542F	Ξ+1
TV	Metted Surfa	ce Area	a (m^2)	: 8.542H	Ξ+3
F	2W		(kN)		J 1 T
	lw Sinkage		(m)	: 1.575E : 1.591E	
	rim at CG		(deg)	: -2.456E	
			. 5.		

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******	*****	*****	*****	*****	******
			RID INFO	RMATION	
	Name	:	tsuR079	SSG File	
Sheet#	NP1 6	NP2	NP	KP	MP
1 2	19	80	1520	3	0 0
3	55	12	1520 660	2	1
4	14	7 7	98 98	2 5	1
5	14			5	1
6	12	12	144	1	0
				PARTICULA	
density (kg/	m^3)= 1025	.000	gravity	$(m/s^2) =$	9.800
T.T.			(4 124	п. о
Wat Wat	erline Len	igtn	(III) (m)	. 4.134	上+∠ □ _ 1
Max	imum Draft		(m)	: 1.033	E+1
Dis	placement		(m^3)	: 1.334	E+4
Wet	ted Surfac	e Area	(m^2)	: 8.542	E+3
LCB	(from ori	gin)	(m)	: 1.018	E+2
TCB	(from ori	gin)	(m)	: 4.134 : 4.421 : 1.033 : 1.334 : 8.542 : 1.018 : 0.000 : -3.536	E+0
VCD	110 11011)	.9111)			E+U
Wat	erplane Ar	ea	(m^2)	: 2.520 : 9.882 : 5.666	E+3
LCF	(from ori	gin)	(m)	: 9.882	E+1
Met	acentric h	eight	(m)	: 5.666	E+0
Mag			(ka)	. 1 200	F±7
Mas	s/densitv		(m^3)	: 1.171	E+4
LCG	(from ori	gin)	(m)	: 9.929	E+1
TCG	(from ori	gin)	(m)	: 0.000	E+0
VCG	trom ori)	.gin)	(m)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	E+0
Radii (of Gyration	n /	(m) :	0.000E+0	(roll)
(abo	uc cg,	`	(m) :	0.000E+0	(vaw)
	ST	EADY F	ORCE AND	RESPONSE	
Shi	p Speed		(m/s)	: 1.286 : 2.497 : 8.542 : 2.768	E+1
Shi	p Speed	7	knots)	: 2.497	E+1
Wet	tea surfac	e area	ι (m 2) (1⊱π)	: 8.542 . 2.760	上+3 〒→2
Rw Cw				: 2.766	E-4
	kage		(m)		
	m at CG		(dèg)	: 5.609 : 1.017	E-2

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*	SWAN	2 2002	SOLVE		*
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******	*****	*****	*****	*****	*****
	Name	:	RID INFO	RMATION SSG File	
	ND1				
5110	eet# NP1 1 6	NP2 80	480	3 3 2 5	MP 0
	2 19	80	480 1520 660	3	0
		12	660	2	1
	4 14 5 14	7 7	98 98	5 5	1 1
	6 12	12		1	0
	 PRINCI	 PAL HYD	 ROSTATIC	PARTICULAR	 S
density	$(kg/m^3) = 102$	25.000	gravity	$(m/s^2) =$	9.800
	Waterline Le Waterline Be Maximum Draf Displacement Wetted Surfa LCB (from or TCB (from or VCB (from or	ength	(m)	: 4.134E	E+2
	Waterline Be	eam	(m)	: 4.421E	3+1
	Displacement	. L	(III) (m^3)	· 1.033E	5+1 7+4
	Wetted Surfa	ace Area	(m^2)	: 8.542E	Z+3
	LCB (from or	rigin)	(m)	: 1.018E	E+2
	TCB (from or	rigin)	(m) (m)	: 0.000E	E+0 E+0
	Waterplane A	Area	(m^2)	: 2.520E	I+3
	Waterplane A LCF (from or Metacentric	height	(m)	: 9.882E	2+0 2+1
	Mass/density	7	(KG) (m^3)	1.200E	S+ / S+4
	LCG (from or	rigin)	(m)	: 9.929E	- S+1
	TCG (from or	rigin)	(m)	: 0.000E	E+0
_	VCG (from or	rigin)	(m)	: -3.947E	E+0
Ra	all of Gyrati (about CG)	on	(m) :	0.000E+0	(roll)
	Mass Mass/density LCG (from or TCG (from or VCG (from or dii of Gyrati (about CG)		(m) :	0.000E+0	(yaw)
	2	STEADY I	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.543E	
	Ship Speed	_	(knots)	: 2.996E : 8.542E	E+1
	Wetted Surfa	ace Area	a (m^2) (kN)	: 8.542E : 6.024E	5+3 7+2
	Cw			: 6.024E	
	Sinkage			: 6.160E	E-1
	Trim at CG		(deg)	: 1.351E	3-1

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*	SWAN2	2002	SOLVE		*
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*****	*****	****	*****	*****	*****
			GRID INFO		
				SSG File	
Shee	t# NP1	NP2	NP 480 1520	KP	MP
	1 6 2 19	80	480	3 3 2	0 0
	3 55	12	660	2	1
	4 14	7		5	1
	5 14	7	98 98	5	1
		12	144	1	0
density (k	PRINCIF 29/m^3)= 102!	5.000	gravity	PARTICULAR (m/s^2) =	9.800
Ta	Istarlina La	nath	(m)	. / 13/	E+2
Ā	Materline Bea	am	(m)	: 4.421	E+1
N	Maximum Draf	t	(m)	: 1.033	E+1
Ι	isplacement		(m^3)	: 1.334	E+4
ν -	letted Surfa	ce Area	a (m^2)	: 8.542	E+3
I	CB (from or	igin)	(m)	: 1.018.	E+2
7	Jaterline Bed Jaximum Draff Displacement Jetted Surfact LCB (from or: CCB (from or: CCB (from or:	igin)	(m)	: -3.536	E+0 E+0
			/^o\		
V	GE (from or	rea iain)	(m 2)	: 2.520 : 9.882	Ľ+3 ⊡.1
I M	Materplane A MCF (from or: Metacentric l	height	(m)	: 5.666	E+1 E+0
			(1)	1 000	
Iv	iass Iacc/dencity		(Kg) (m^3)	. 1.200.	Ľ+/ F⊥4
T	.CG (from or	iain)	(m)	. 9 929	E+1
Ī	CG (from or	igin)	(m)	: 0.000	E+0
	CG (from or:	igin)	(m)	: -3.947	E+0
Radi	i of Gyratic	n	(m) :	0.000E+0	(roll)
(a	bout CG)		(m) :	0.000E+0	(pitch)
	Mass Mass/density MGG (from or: MGG (from or		(m) :	0.000E+0	(yaw)
				RESPONSE	
5	Ship Speed Ship Speed Jetted Surfac Sw		(m/s)	: 1.800	E+1
S	hip Speed		(knots)	: 3.495	E+1
<u> </u>	letted Surfa	ce Area	a (m^2)	: 8.542	E+3
F	LW		(KN)	: 1.199	E+3
	lw Sinkage		(m)	. 0.102	
	rim at CG		(deg)	: 6.390 : 2.422	E-1
-	00		(~ 0 5 /	. 2.122	

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	Name		GRID INFO		
	 + ND1	NP2	NP	KP	MP
511	eet# NP1 1 6	80	480	3	0
	2 19	80	480 1520 660	3	0
		12	660	2 5	1
	4 14 5 14		98 98	5 5	1 1
	6 12			1	0
	 PRINC	IPAL HY	DROSTATIC	PARTICULAR	 S
density	$(kg/m^3) = 10$	25.000	gravity	(m/s^2) =	9.800
	Waterline I	Length	(m)	: 4.134E	E+2
	Waterline B	Beam	(m)	: 4.421E	2+1
	MaxImum Dra	ill nt	(m^3)	: 1.033E	5+1 7±4
	Wetted Suri	ace Are	a (m^2)	: 8.542E	1+3
	LCB (from o	origin)	(m)	: 1.129E	E+2
	TCB (from o	origin)	(m)	4.421E : 1.033E : 1.334E : 8.542E : 1.129E : 0.000E : -3.536E	I+0
	Waterplane	Area	(m^2)	: 2.520E	C+3
	Metacentric	origin) c height	(m) (m)	: 2.520E : 9.987E : 5.666E	5+1
	Mass Magg/dengit	- 77	(kg)	: 1.200E	i+'/ !_4
	LCG (from a	origin)	(m)	9.929F	:- :+1
	TCG (from o	origin)	(m)	: 0.000E	E+ 0
	VCG (from o	rigin)	(m)	: -3.947E	E+0
Ra	dii of Gyrat	ion	(m) :	0.000E+0	(roll)
	Mass Mass/densit LCG (from of TCG (from of VCG (from of dii of Gyrat (about CG)		(III) : (m) :	0.000E+0 ((yaw)
		STEADY		RESPONSE	
	Ship Speed		(m/s)	: 7.720E : 1.499E : 8.542E : 1.861E : 7.134E	E+0
	Ship Speed		(knots)	: 1.499E	1+1
	Wetted Surf	ace Are	a (m^2) (kN)	: 8.542E	5+3 7⊥1
	Cw		(1/11/)	: 7.134F	1-1 1-5
	Sinkage		(m)	: -3.024E	G+ O
	Trim at CG		(deg)	: -2.065E	E+0

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		(RID INFO	RMATION	
				SSG File	
Sne	et# NP1 1 6	NP2	NP	KP	MP 0
	2 11	37 37 12	222 407 312	3 3 2	0
	3 26	12	312	2	1
	4 7	7	49	5	1
	5 7	7	49	5	1
			144	1	0
	 PRTNCTD	AI HVD	ROSTATIC	PARTICULAR	 RS
density	kg/m^3) = 1025	5.000	gravity	$(m/s^2) =$	9.800
	Waterline Ler	nath	(m)	. / 13/	E+2
	Waterline Ber Maximum Draff Displacement Wetted Surfac LCB (from ori TCB (from ori VCB (from ori	am	(m)	: 4.420	E+1
	Maximum Draft	5	(m)	: 1.033	E+1
	Displacement	_	(m^3)	: 1.286	E+4
	Wetted Surfac	ce Area	a (m^2)	: 8.421	E+3
	LCB (from or	igin)	(m)	: 1.134	E+∠ E - 0
	VCB (from or	igin)	(III) (m)	3 403	E+0
	Waterplane An LCF (from ori Metacentric h	rea	(m^2)	: 2.444	E+3
	LCF (from ori	igin)	(m)	: 1.007	E+2
	Metacentric h	neight	(m)	: 4.478	E+0
			(1)	1 000	
	Macc/dencity		(Kg)	: 1.200	比+ / 다ㅗ/
	ICG (from or	iain)	(m)	. 1 113	штэ Е+2
	TCG (from ori	igin)	(m)	: 0.000	E+0
	Mass Mass/density LCG (from ori TCG (from ori VCG (from ori ii of Gyratio about CG)	igin)	(m)	: -3.947	E+0
Rad	ii of Gyratio	n	(m) :	0.000E+0	(roll
(about CG)		(m) :	0.000E+0	(pitch
			(m) :	0.000E+0	(yaw)
	S7	ready i	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.028	E+1
	Ship Speed		(knots)	: 1.996	E+1
	Ship Speed Ship Speed Wetted Surface Rw	ce Area	a (m^2)	: 8.421	E+3
	Rw		(kN)	: 4.182	E+0
	CW			. 9.100	E-0
	Sinkage		(m)	: -1.919 : -3.211	E-1
	Trim at CG		(deg)	: -3.211	E-1

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*		SWAN2	2002	SOLVE		
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				GRID INFO	RMATION	
		Name			SSG File	
	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3 3 2	0
	2	19 55	80	1520	3	0
	3 4	55	12	660	2	1
	4 5	14 14	7	98	5 5	1
	5 6	12	12	98 144	5 1	1
_		PRINCIP	AL HYI	DROSTATIC	PARTICULA	RS
dens					(m/s^2) =	
	Wate	rline Le	ngth	(m)	: 4.134	1E+2
	Wate	rline Bea	am	(m)	: 4.421	LE+1
	Maxi	mum Drafi	t	(m)	: 1.033	3E+1
	Disp	Lacement	_	(m^3)	: 1.334	1E+4
	Wett	ed Surfa	ce Are	a (m 2)	: 8.542	2E+3
	TCB	(from or	igin)	(m)	: 1.129	∄E+∠ >□. ο
	VCB	(from or	igin)	(m)	: -3.536	5E+0
				· · · · · · · · · · · · · · · · · · ·	: 4.134 : 4.421 : 1.033 : 1.334 : 8.542 : 1.129 : 0.000 : -3.536	
	wate	rplane A	rea	(m 2)	: 2.520 : 9.985 : 5.666)E+3
	LCF Moto	(irom or	igin)	(m)	: 9.98	/E+T
	Mass	,		(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	LE+4
	LCG	(from or:	igin)	(m)	: 9.929	∂E+1
	TCG	(from or	igin)	(m)	: 0.000	JE+0
	VCG	(irom or	rgin)	(m)	: -3.94	/比+U - /ゕープフ
	rauli Ol	. Gyraulo + cc\	111	(III) :	0.000E+0 0.000E+0	(LOII)
	(abou	c CG)		(m) •	0.0005+0	(hten)
			TEADY	FORCE AND	RESPONSE	
	Ship	Speed		(m/s)	: 1.286	E+1
	Ship	Speed		(knots)	: 2.497	/E+1
	Wett	ea Surfa	ce Are	a (m ²)	: 1.286 : 2.497 : 8.542 : 9.278 : 1.283	2E+3
	RW Ct.t			(KN)	: 9.278	1 년 V 2 단 + T
	Sink	age at CG		(111)	: -1.763 : -1.385	
	TTTI	at CG		(deg)	: -1.385) E+U

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*****	*****	****	*****	*****	****
		(GRID INFO	RMATION	
	Name			SSG File	
Sh	eet# NP1	NP2	NP	KP	MP
	1 6 2 19	80	NP 480 1520	3 3	0
		80	1520	3 2	0
	3 55 4 14	12 7	660	2 5	1 1
	5 14	7	98 98	5 5	1
		1 2	144	1	0
	PRINCIP	AL HYD	ROSTATIC	PARTICULAR	S
density	$(kg/m^3) = 1025$	5.000	gravity	$(m/s^2) =$	9.800
	Waterline Ler	ngth	(m)	: 4.1341	±+2
	Waterline Bea	am	(m)	: 4.4211	3+1
	Maximum Draft	t	(m)	: 1.0331	Z+1
	Displacement	_	(m^3)	: 1.3341	3+4
	Wetted Surface	ce Are	a (m´2)	: 8.5421	±+3
	LCB (from or:	igin)	(m)	: 1.1291	5+2
	ICB (from or:	rdiu)	(m)	: 0.0001	5+U 7+0
	Waterline Bee Maximum Draft Displacement Wetted Surfac LCB (from or: TCB (from or: VCB (from or:	 -A+111)	(111)	: -3.5361	
· 					
	Waterplane And LCF (from or: Metacentric h	igin)	(m)	: 9.9871	Z+1
	Metacentric h	height	(m)	: 5.6661	±+0
	Mass		(kg)	: 1.2001	E+7
	Mass/density		(m^3)	: 1.1711	E+4
	LCG (from or:	igin)	(m)	: 9.9291	3+1
	TCG (from or:	igin)	(m)	: 0.0001	∑ +0
	VCG (from or	igin)	(m)	: -3.947I	∃+0
Ra	dii of Gyratio	n	(m) :	0.000E+0	roll
	Mass Mass/density LCG (from or: TCG (from or: VCG (from or: dii of Gyratio (about CG)		(m) :	0.000E+0	(pitch
			(m) :	U.UUUE+0	(yaw)
	S	TEADY	FORCE AND	RESPONSE	
	Shin Sneed		(m/⊂)	· 1 P731	7.∔1
	Ship Speed		(m/s)	: 1.5431 · 2.9961	3+1 3+1
	Ship Speed Ship Speed Wetted Surface	ce Are	(m/s) (knots) a (m^2)	: 1.5431 : 2.9961	Ξ+1 Ξ+1 ₹+3
	Ship Speed Ship Speed Wetted Surfac	ce Are	(m/s) (knots) a (m^2) (kN)	: 1.5431 : 2.9961 : 8.5421 : 5.6301	E+1 E+1 E+3 E+2
	Ship Speed Ship Speed Wetted Surfac Rw Cw	ce Are		: 1.5431 : 2.9961 : 8.5421 : 5.6301 : 5.4021	E+1 E+1 E+3 E+2 E-4
	Ship Speed Ship Speed Wetted Surfac Rw Cw Sinkage	ce Are	(m/s) (knots) a (m^2) (kN)	: 1.543i : 2.996i : 8.542i : 5.630i : 5.402i : -6.026i : -7.101i	5-4

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*	Massachuset	ts Inst	itute of '	Technology	*
*****	*****	*****	*****	*****	*****
	Name		GRID INFO		
	 + ND1	NP2	NP	KP	MP
5110	eet# NP1 1 6	80	480	3	0
	2 19	80	480 1520 660	3	0
		12	660	2 5	1
	4 14 5 14		98 98	5 5	1 1
	6 12			1	0
	PRINC	IPAL HY	DROSTATIC	PARTICULARS	 3
density	$(kg/m^3) = 10$	025.000	gravity	$(m/s^2) =$	9.800
	Waterline 1	Length	(m)	: 4.134E : 4.421E : 1.033E : 1.334E : 8.542E : 1.129E : 0.000E : -3.536E	1+2
	Waterline I	Beam	(m)	: 4.421E	l+1
	Displacemen	dil nt	(m^3)	: 1.033E	ı+⊥ !+4
	Wetted Sur	face Are	a (m^2)	: 8.542E	1+3
	LCB (from o	origin)	(m)	: 1.129E	1+2
	TCB (from o	origin)	(m)	: 0.000E	S+0
	Waterplane	Area	(m^2)	: 2.520E	1+3
	Metacentri	origin) c height	(m) (m)	: 2.520E : 9.987E : 5.666E	i+1
	Mass/densit	- 17	(KG) (m^3)	: 1.200E	ı+ / !+4
	LCG (from	origin)	(m)	: 9.929E	+1
	TCG (from o	origin)	(m)	: 0.000E	I+0
_	VCG (from o	origin)	(m)	: -3.947E	(+0
Ra	ull of Gyrat	ion	(m) :	0.000E+0	(roll)
	Mass Mass/densit LCG (from of TCG (from of VCG (from of dii of Gyrat (about CG)		(m) :	0.000E+0 ((yaw)
		STEADY	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.800E	+1
	Ship Speed	C	(knots)	: 3.495E	+1
	Wetted Sur	cace Are	ea (m^2) (kN)	: 8.542E	1+3 1+3
	Cw		(VIA)	: 1.800E : 3.495E : 8.542E : 1.833E : 1.292E	i - 3
	Sinkage		(m)	: -4.302E	+0
	Trim at CG		(deg)	: -2.294E	I+0

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		SWAN2	2002	SOLVE		
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*****	******	*****	****	*****	*****	*****
				GRID INFO		
			:	tsuR081	SSG File	
	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3	0
	2	19	80	1520	3	0
	3	55	12	660	3 3 2 5	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
		PRINCIPA	AL HYI	DROSTATIC	PARTICULA	 RS
densi	ty (kg/m	^ 3)= 1025	5.000	gravity	$(m/s^2) =$	9.80
	Wate	rline Len	igth	(m)	: 4.134 : 4.586 : 1.033 : 1.334 : 8.542 : 9.659 : 0.000 : -3.536	E+2
	Wate	rline Bea	ım	(m)	: 4.586	E+1
	Maxi	mum Draft		(m)	: 1.033	E+1
	Disp	lacement		(m^3)	: 1.334	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.542	E+3
	LCB	(from ori	.gin)	(m)	: 9.659	E+1
	TCB	(from ori	.gin)	(m)	: 0.000	E+0
	VCB	(from ori	.gin)	(m)	: -3.536	E+0
	Wate	rplane Ar	rea	(m^2)	: 2.520	E+3
	LCF	(from ori	gin)	(m)	: 9.832	E+1
	Meta	centric h	eight	(m)	: 2.520 : 9.832 : 5.769	E+0
					: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	
	Mass	/densitv		(m^3)	: 1.171	E+4
	TCG	(from ori	ain)	(m)	9 929	E+1
	TCG	(from ori	ain)	(m)	. 0.000	E+0
	VCG	(from ori	ain)	(m)	: -3.947	E+0
	Radii of	Gyratio	n	(m) :	0.000E+0	(roll
	(about	+ CG)		(m) ·	0.000E+0	(pitcl
	(azou			(m) :	0.000E+0	(yaw
		ST			RESPONSE	
	Shin	ST			RESPONSE	
	Ship Shin	Speed Speed			RESPONSE: 7.720: 1.499	
	Ship Ship Wett	ST Speed Speed			RESPONSE: 7.720: 1.499: 8.542	
	Ship Ship Wett Rw	Speed Speed Speed ed Surfac			RESPONSE: 7.720: 1.499: 8.542: 5.555	
	Ship Ship Wett Rw Cw	ST Speed Speed ed Surfac			RESPONSE: 7.720: 1.499: 8.542: 5.555: 2.129	
	Ship Ship Wett Rw Cw Sink	ST Speed Speed ed Surfac	EADY 	force And (m/s) (knots) a (m^2) (kN)	RESPONSE: 7.720: 1.499: 8.542: 5.555: 2.129: 1.273: 4.049	E+0 E+1 E+3 E+1

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* * *	SWAN	12 2002	SOLVE		
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	N		GRID INFO		
	Name			SSG File	
She	eet# NP1				MP
211	1 6	80	480	3	0
	2 19	80	NP 480 1520	3	0
	3 55	1.2	660	∠	1
	4 14	7		5	1
	5 14	7		5	1
	6 12	12	144	1	0
	PRTNCT	PAI HYP	ROSTATIC	PARTICULA	 RS
density	(kg/m^3) = 10:	25.000	gravity	$(m/s^2) =$	9.800
· ·	Waterline L	onath	(m)	. / 13/	E+2
	Waterline B	eam	(m)	: 4.586	E+1
	Maximum Dra	ft	(m)	: 1.033	E+1
	Displacemen	t	(m^3)	: 1.334	E+4
	Wetted Surf	ace Area	a (m^2)	: 8.542	E+3
	LCB (from o	rigin)	(m)	: 9.659	E+1
	TCB (from o	rigin)	(m)	: 0.000	E+0
	Materline Be Maximum Dra: Displacemen Wetted Surfi LCB (from o: TCB (from o: VCB (from o:	rigin)	(m)	: -3.536	E+0
	ICF (from o	nica ricin)	(III ∠) (m)	. 9 837	E+1
	Waterplane A LCF (from or Metacentric	height	(m)	: 5.769	E+0
	Mass		(kq)	: 1.200	E+7
	Mass/densit	У	(m^3)	: 1.171	E+4
	LCG (from o	rigin)	(m)	: 9.929	E+1
	TCC (from o	~ i ~ i ~ l	/ \	: 0.000	E+0
	100 (1100 0.	119111)	(111)		
	VCG (from o	rigin)	(m)	: -3.947	E+0
Rad	VCG (from or	rigin) .on	(m) (m) :	: -3.947 0.000E+0	E+0 (roll
Rad	VCG (from or dii of Gyrati (about CG)	rigin) on	(m) (m) : (m) :	: -3.947 0.000E+0 0.000E+0	E+0 (roll (pitch
Rad	VCG (from or dii of Gyrati (about CG)	rigin) .on	(m) : (m) : (m) :	: -3.947 0.000E+0 0.000E+0 0.000E+0	E+0 (roll (pitch (yaw)
Rac	Mass Mass/density LCG (from or TCG (from or VCG (from or dii of Gyrati (about CG)	rigin) .on	(m) (m) : (m) : (m) :	: -3.947 0.000E+0 0.000E+0 0.000E+0	E+0 (roll (pitch (yaw)
Rac	VCG (from o	rigin) .on	(m) (m) : (m) : (m) :	: -3.947 0.000E+0 0.000E+0 0.000E+0	E+0 (roll (pitch (yaw)
Rac	VCG (from o dii of Gyrati (about CG)	rigin) .on	(m) (m) (m) (m) : (m) : (m) : (m) :	: -3.947 0.000E+0 0.000E+0 0.000E+0	E+0 (roll (pitch (yaw)
Rac	VCG (from o VCG (from o dii of Gyrati (about CG)	rigin) .on	(m) :	: -3.947 0.000E+0 0.000E+0 0.000E+0	E+0 (roll (pitch (yaw)
Ra(: -3.947 0.000E+0 0.000E+0 0.000E+0	E+0 (roll (pitch (yaw)
Rad		STEADY	FORCE AND	RESPONSE	
Rad		 STEADY 1	FORCE AND	RESPONSE	
Rad		 STEADY 1	FORCE AND	RESPONSE	
Rad	Ship Speed Ship Speed Wetted Surf	 STEADY 1	FORCE AND (m/s) (knots) a (m^2)	RESPONSE: 1.028: 1.996: 8.542	E+1 E+3
Rac	Ship Speed Ship Speed Wetted Surfa	 STEADY 1	force And (m/s) (knots) a (m^2) (kN)	RESPONSE : 1.028 : 1.996 : 8.542 : 4.750	E+1 E+3 E+1
Rac	Ship Speed Ship Speed Wetted Surf	 STEADY 1	FORCE AND (m/s) (knots) a (m^2)	: 1.028 : 1.996 : 8.542 : 4.750	 E+1 E+1 E+3 E+1 E+1

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t t	SWAN	12 2002	SOLVE		
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	Name		GRID INFO tsuR081	RMATION SSG File	
She	eet# NP1	NP2	NP	KP	MP
	1 6 2 19	80	480 1520	3	0
	3 55	12	660		1
	4 14	7 7	98 98	5	1
	5 14			5	1
	6 12 	12	144	1 	0
density	$(kg/m^3) = 10$	25.000	gravity		9.800
	Waterline L Waterline B Maximum Dra Displacemen	ength	(m)	: 4.134	
	Waterline B	eam ft	(m)	: 4.586 : 1.033	
	Displacemen	t.	(m^3)	: 1.334	
	Wetted Surf	ace Are	a (m^2)	: 8.542	2E+3
	LCB (from o	rigin)	(m)	: 9.659	9E+1
	Displacemen Wetted Surf LCB (from o TCB (from o VCB (from o	rigin) rigin)	(m) (m)	: 0.000	0E+0 5E+0
	Waterplane .	 Area	(m^2)	: 2.520	 DE+3
	LCF (from o	rigin)	(m)	: 9.832	2E+1
	Waterplane . LCF (from o Metacentric	height	(m)	: 5.769	9E+0
	Mass Mass/densit LCG (from o TCG (from o VCG (from o dii of Gyrati (about CG)		(kg)	: 1.200	DE+7
	Mass/densit	У	(m ⁻ 3)	: 1.171	LE+4
	TCG (from o	rigin)	(III) (m)	9.929)E+0 >¤+T
	VCG (from o	rigin)	(m)	: -3.947	7E+0
Rad	dii of Gyrati	.on	(m) :	0.000E+0	(roll
	(about CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch (yaw)
				RESPONSE	
	Ship Speed Ship Speed		(m/s)	: 1.286	5E+1
	Ship Speed Wetted Surf	200 7	(knots)	: 2.49 ⁵ : 8.54 ²	/E+1
	welled Suri	ace Are		: 8.542	4E+3
			(kN)	• 3 44.	₹ H: ∓ フ
	Rw Cw			: 3.443 : 4.756	5E-4
	Rw			: 4.756	5E-4

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				GRID INFO	RMATION	
		Name			SSG File	
	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
		6	80	480	3 3 2	0
	2	19 55	80	1520	3	0
	4	14	7	660	5	1 1
	5	14	7	98	5	1
	6	12	12	144	1	0
densi	ty (kg/m	^ 3)= 1025	5.000	gravity	PARTICULAI (m/s^2) =	RS 9.800
	Wate	rline Ler		(m)	. 1131	F+2
	Wate.	rline Ber	ig cii	(III) (m)	. 4.134	E+Z E±1
	Mace.	mum Draft	-	(m)	. 1.033	E+1
	Disn	lacement	-	(m^3)	1.334	E+4
	Wett	ed Surfac	ce Are	a (m^2)	: 8.542	E+3
	LCB	(from or	lgin)	(m)	: 9.659	E+1
	TCB	(from ori	igin)	(m)	: 0.000	E+0
	VCB	(from ori	igin)	(m)	: 4.134 : 4.586 : 1.033 : 1.334 : 8.542 : 9.659 : 0.000 : -3.536	E+0
	Wate:	rplane Aı	rea	(m^2)	: 2.520 : 9.832 : 5.769	E+3
	LCF	(from ori	igin)	(m)	: 9.832	E+1
	Mass			(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	lgin)	(m)	: 9.929	E+1
	TCG	(from ori	igin)	(m)	: 0.000	E+0
	VCG	(irom ori	ıgin)	(m)	: -3.947	E+0
	Radii of	Gyratio	n	(m) :	0.000E+0 0.000E+0	(roll
	(abou	E CG)		(m) :	0.000E+0	(pitcr
					0.000E+0	(yaw)
				FORCE AND	RESPONSE	
		S7				
				(/)		
	Ship			(m/s)	: 1.543	E+1
	Ship Ship			(m/s) (knots)	: 1.543 : 2.996	E+1 E+1
	Ship Ship Wett			(m/s) (knots) a (m^2)	: 1.543 : 2.996 : 8.542	E+1 E+1 E+3
	Ship Ship Wett Rw			(m/s) (knots) a (m^2) (kN)	: 1.543 : 2.996 : 8.542 : 4.884	E+1 E+1 E+3 E+2 E-4
	Ship Ship Wett Rw Cw Sink	Speed Speed ed Surfac		(m/s) (knots) a (m^2) (kN)	: 1.543 : 2.996 : 8.542 : 4.884 : 4.686 : 2.868	

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*****	*****	*****	****	*****	******	*******
				RID INFO		
	Na	me	:	tsuR081	SSG File	
Sh	eet# NP	1 1	NP2	NP 480 1520 660 98	KP	MP
	1 2 1	6	80	480	3 3 2 5	0
	2 1 3 5	9 5	12	660	2	1
	4 1	4	7	98	5	1
	5 1	4	7	98	5	1
	6 1	2 	12	144		0
density	$(kg/m^3) =$	1025.0	000	gravity		9.800
	 Waterline	Lenat	 h	(m)	: 4.13 : 4.58 : 1.03 : 1.33 : 8.54 : 9.65 : 0.00 : -3.53	 4E+2
	Waterline	Beam		(m)	: 4.58	6E+1
	Maximum D	raft		(m)	: 1.03	3E+1
	Displacem	ent	7	(m^3)	: 1.33	4E+4
	TCR (from	iriace Origi	n)	(III Z) (m)	9 65	∠Ľ+3 9E+1
	TCB (from	origi	n)	(m)	: 0.00	0E+0
	VCB (from	origi	.n)	(m)	: -3.53	6E+0
	Waterplan	e Area	ı	(m^2)	: 2.52 : 9.83 : 5.76	0E+3
	LCF (from	origi	n)	(m)	: 9.83	2E+1
	Mass Mass/dens LCG (from TCG (from VCG (from dii of Gyr. (about CG)			(kg)	: 1.20	0E+7
	Mass/dens	ity	~ \	(m ³)	: 1.17	1E+4
	TCG (from	origi origi	n)	(m)	: 0.00	0E+0
	VCG (from	origi	n)	(m)	: -3.94	7E+0
Rad	dii of Gyr	ation		(m) :	0.000E+0	(roll)
	(about CG)		(m) : (m) :	0.000E+0 0.000E+	(pitch) 0 (yaw)
		STEA	DY F	ORCE AND	RESPONSE	
	Ship Spee	 :d		(m/s)	: 1.80	0E+1
	Ship Spee	ed	(knots)	: 3.49	5E+1
	Wetted Su	rface	Area	(m^2)	: 8.54	2E+3
	KW Cw			(KN)	: 1.80 : 3.49 : 8.54 : 9.88 : 6.96	1E+2 6E-4
	Sinkage			(m)	: 3.70	9E+0
	Trim at C	'G		(deg)	: 1.87	

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* ************************************	*
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GRID INFORMATION	
Name : tsuR082 SSG File	
Sheet# NP1 NP2 NP KP MP	
1 6 80 480 3 0	
2 19 80 1520 3 0 3 55 12 660 2 1	
3 55 12 660 2 1 4 14 7 98 5 1	
4 14 7 98 5 1 5 14 7 98 5 1	
6 12 12 144 1 0	
PRINCIPAL HYDROSTATIC PARTICULARS density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.80$	0
Waterline Length (m): 4.134E+2	
Waterline Beam (m) : 4.586E+1	
Maximum Draft (m): 1.033E+1	
Displacement (m 3): 1.334E+4 Wothed Surface Area (m^2) . 9.542E+2	
LCB (from origin) (m) : 1.018E+2	
TCB (from origin) (m) : 0.000E+0	
Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.334E+4 Wetted Surface Area (m^2): 8.542E+3 LCB (from origin) (m): 1.018E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.536E+0	
Waterplane Area (m^2) : 2.520E+3 LCF (from origin) (m) : 9.882E+1 Metacentric height (m) : 5.769E+0	
LCF (from origin) (m) : 9.882E+1	
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll (about CG) (m) : 0.000E+0 (pitc (m) : 0.000E+0 (yaw	
Mass/density (m^3) : 1.171E+4	
LCG (from origin) (m): 9.929E+1	
VCG (from origin) (m) : -3.947E+0	
Radii of Gyration (m) : 0.000E+0 (roll	L)
(about \widehat{CG}) (m) : 0.000E+0 (pitc	h)
(m) : 0.000E+0 (yaw)
STEADY FORCE AND RESPONSE	
Ship Speed (m/s): 7.720E+0 Ship Speed (knots): 1.499E+1 Wetted Surface Area (m^2): 8.542E+3 RW (kN): 5.443E+1 CW : 2.086E-4	
Ship Speed (m/s): 7.720E+0 Ship Speed (knots): 1.499E+1	
Wetted Surface Area (m^2) : 8.542E+3	
Rw (kN): 5.443E+1 Cw : 2.086E-4	
Sinkage (m): -7.766E-2	
Trim at CG (deg) : -3.768E-1	

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Massachusetts Institute of Technology	
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GRID INFORMATION	
Name : tsuR082 SSG File	
Sheet# NP1 NP2 NP KP 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5	MP
1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5	U
2 19 80 1520 3	0
3 55 12 660 2	1
4 14 7 98 5	1
5 14 7 98 5	1
6 12 12 144 1	0
PRINCIPAL HYDROSTATIC PARTICULARS	
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9$.800
Waterline Length (m) 4 124E	
Waterline Bengun (m) : 4.1346+	1
Marrimum Droft (m) : 4.500E+	1 1
Dianlacement (m^2) 1 224E	. T
Displacement (m 3): 1.334E+	-4
Welled Surface Area (M Z) : 8.54ZE+	- 3
ECB (from origin) (m): 1.018E+	- 2
Waterline Length (m): 4.134E+ Waterline Beam (m): 4.586E+ Maximum Draft (m): 1.033E+ Displacement (m^3): 1.334E+ Wetted Surface Area (m^2): 8.542E+ LCB (from origin) (m): 1.018E+ TCB (from origin) (m): 0.000E+ VCB (from origin) (m): -3.536E+	-0
Waterplane Area (m^2) : 2.520E+	- 3
LCF (from origin) (m) : 9.882E+	·1
Waterplane Area (m^2) : 2.520E+ LCF (from origin) (m) : 9.882E+ Metacentric height (m) : 5.769E+	· 0
Maga (lag) 1 2000.	 -7
Mass (kg): 1.200E+	
Mass/density (m^3) : 1.200E+	-4
Mass/density (m^3): 1.171E+ LCG (from origin) (m): 9.929E+	·4 ·1
Mass/density (m ²): 1.200±+ Mass/density (m ²): 1.171E+ LCG (from origin) (m): 9.929E+ TCG (from origin) (m): 0.000E+	-4 -1 -0
Mass/density (m ²): 1.200E+ Mass/density (m ²): 1.171E+ LCG (from origin) (m): 9.92E+ TCG (from origin) (m): 0.000E+ VCG (from origin) (m): -3.947E+	-4 -1 -0 -0
Mass (Rg) : 1.200E+ Mass/density (m^3) : 1.171E+ LCG (from origin) (m) : 9.929E+ TCG (from origin) (m) : 0.000E+ VCG (from origin) (m) : -3.947E+ Radii of Gyration (m) : 0.000E+0 (m)	-4 -1 -0 -0 roll)
Mass (Rg) : 1.200E+ Mass/density (m^3) : 1.171E+ LCG (from origin) (m) : 9.929E+ TCG (from origin) (m) : 0.000E+ VCG (from origin) (m) : -3.947E+ Radii of Gyration (m) : 0.000E+0 (p) (about CG) (m) : 0.000E+0 (p)	-4 -1 -0 -0 roll) oitch
Mass (kg): 1.200E+ Mass/density (m^3): 1.171E+ LCG (from origin) (m): 9.929E+ TCG (from origin) (m): 0.000E+ VCG (from origin) (m): -3.947E+ Radii of Gyration (m): 0.000E+0 (p	4 ·1 ·0 ·0 roll) oitch (yaw)
Mass/density (m^3): 1.200±+ Mass/density (m^3): 1.171E+ LCG (from origin) (m): 9.929E+ TCG (from origin) (m): 0.000E+ VCG (from origin) (m): -3.947E+ Radii of Gyration (m): 0.000E+0 (p	-4 -1 -0 -0 roll) oitch (yaw)
(111) . 0.000110 (-4 -1 -0 -0 roll) oitch (yaw)
(111) . 0.000110 (4 -1 -0 -0 roll) pitch (yaw)
()	4 -1 -0 -0 roll) pitch (yaw)
STEADY FORCE AND RESPONSE	

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*	SWAN2	2002	SOLVE		*
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	Name		GRID INFO		
				SSG File	
Sheet#	NP1	NP2	NP	KP	MP
1	6	80	480	3	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	NP 480 1520 660 98	5 5	1
5	14	7	98	5	1
6	12	12	144	1	0
	PRINCIPA	L HYD	ROSTATIC	PARTICULA	RS
density (kg/r	n^3) = 1025	.000	gravity	$(m/s^2) =$	9.800
Wate	erline Leng	gth	(m)	: 4.134 : 4.586 : 1.033 : 1.334 : 8.542 : 1.018 : 0.000 : -3.536	E+2
Wate	erline Bear	n	(m)	: 4.586	E+1
Max	lmum Drait		(m) (^2)	1.033	3E+1
DIS	pracement	2 7 200	(III 3)	. 1.334	:上+4) ロ・2
T.CB	from ori	rin)	a (III 2) (m)	. 0.342	.ロ+3 RF±2
TCB	(from original	gin)	(m)	. 0.000)E+0
VCB	(from original	gin)	(m)	: -3.536	E+0
Wate	erplane Are	ea	(m^2)	: 2.520 : 9.882 : 5.769	E+3
LCF	(from orig	gin)	(m)	: 9.882	E+1
Meta	acentric h	eight	(m)	: 5.769	9E+0
Maca	s/densitv		(m^3)	. 1.200	E+4
I.CG	(from orio	ain)	(m)	9.929	E+1
TCG	(from orio	gin)	(m)	: 0.000	E+0
VCG	(from orig	gin)	(m)	: -3.947	'E+0
Radii o	f Gyration	Ĺ	(m) :	0.000E+0	(roll)
(aboı	ıt CG)		(m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	ST	EADY :	FORCE AND	RESPONSE	
Shir	Speed		(m/s)	: 1.286 : 2.497 : 8.542 : 2.918 : 4.031	E+1
Shir	Speed	_	(knots)	: 2.497	E+1
Wett	ed Surface	e Are	a (m^2)	: 8.542	2E+3
Rw C			(KN)	: 2.918	5E+Z
CW C4m1	7300		(m)	: 4.031 : 4.924	.b-4 D-1
	kage n at CG		(m) (deg)	: 4.924	
				-1.940	

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	Nan	ne :	GRID INFO	ORMATION SSG File	
Sh	eet# NP1 1 6 2 19 3 55 4 14	NP2	NP	KP	MP
	1 1	80	1520	3 3 2 5	0
	2 15	9 80	1520	3	1
	3 55	1 7	660	∠ -	
	4 14	ŧ /	96	5	1
	6 12	12	98 144	5 1	1 0
	υ 12 	. 12			
	PRIN	CIPAL HY	DROSTATIC	PARTICULA	 RS
density	$(kg/m^3) =$	1025.000	gravity	$(m/s^2) =$	9.800
	Waterline	Length	(m)	: 4.134 : 4.586 : 1.033 : 1.334 : 8.542 : 1.018 : 0.000 : -3.536	E+2
	Waterline	Beam	(m)	: 4.586	E+1
	Maximum D	raft	(m)	: 1.033	E+1
	Displacem	ent.	(m^3)	: 1.334	E+4
	Wetted Su	rface Are	ea (m^2)	: 8.542	E+3
	LCB (from	origin)	(m)	: 1.018	E+2
	TCB (from	origin)	(m)	0.000	E+0
	VCB (from	origin)	(m)	: -3.536	E+0
	 Waternlan	e Area	(m^2)	· 2 520	 IE+3
	LCF (from	origin)	(m)	9.882	E+1
	Metacentr	ic height	(m)	: 2.520 : 9.882 : 5.769	E+0
			(1)		
	Mass		(Kg)	: 1.200	D . 4
	mass/dens	TrÀ	(111 3)	: 1.1/1	.D+4
	LCG (Irom	origin)	(m)	9.929	/E・V
	ICG (ITOM	origin)	(m)	: 0.000	/E+U
D-	VCG (IIOIII	origin)	(III)	0 000000	L+U
Rac	TI OF GALS	ILTOI1	(III) :	0.00011.0	(LOII)
	Mass Mass/dens LCG (from TCG (from VCG (from dii of Gyra (about CG)		(III) :	0.000E+0	(Asm) (biccu
		STEADY	FORCE AND	RESPONSE	
	Ship Spee	d	(m/s)	: 1.543 : 2.996 : 8.542 : 5.947 : 5.706 : 5.120	E+1
	Ship Spee	d	(knots)	: 2.996	E+1
	Wetted Su	rface Are	ea (m^2)	: 8.542	E+3
	Rw		(kN)	: 5.947	'E+2
	Cw			: 5.706	E-4
	Sinkage		(m)	: 5.120	E-1
	Trim at C	G	(deg)	: 8.472	E-2
	Trim at C	G	(deg)	: 8.472	E-2

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	Mama		RID INFO		
	Name				
Sheet	# NP1	NP2	NP	KP	MP
	1 6	80	480	3	0
2	2 19	80	1520	3 2	0
3	3 55	12	660	2	1
	1 14	7	98	5	1
	5 14	7	NP 480 1520 660 98 98	5	1
6	5 12	12	144	1	0
	PRINCIPA	L HYD	ROSTATIC	PARTICULAR	RS
density (k	$g/m^3) = 1025$.000	gravity	$(m/s^2) =$	9.800
W	aterline Leng	gth	(m)	: 4.134	E+2
W	aterline Bear	n	(m)	: 4.586	E+1
M	aximum Draft		(m)	: 1.033	E+1
D	isplacement		(m^3)	: 1.334	E+4
W	etted Surface	e Area	ı (m^2)	: 8.542	E+3
Д	CB (from orig	gin)	(m)	: 1.018	E+2
T.	CB (from orig	gin)	(m)	: 0.000	E+0
v	aterline Leng aterline Bear aximum Draft isplacement etted Surface CB (from original CB (from original	3 T T T)	(111)	3.336	E+U
W	aterplane Are	ea.	(m^2)	: 2.520	E+3
L	CF (from orio	gin)	(m)	: 9.882	E+1
M	aterplane Are CF (from orio etacentric he	eight	(m)	: 5.769	E+0
M	lass lass/density CG (from origing CG)		(kg)	: 1.200	E+7
M	ass/density		(m^3)	: 1.171	E+4
L	CG (from orig	gin)	(m)	: 9.929	E+1
'I'	CG (from orig	JIN)	(m)	: 0.000	타+U 타+O
V Padi-	i of Gyration	3 TII)	(m) :	0 00000	(roll)
raui.	hout CG)	. ((III) :	0.000E+0	(nitch)
·(α	bout co,	`	(m) :	0.000E+0	(vaw)
				RESPONSE	
0	him Omend		(/)	: 1.800	 F⊥1
۵ 9	hip Speed hip Speed	1	knots)	3 495	±+1
C. [k]	nip byccu etted Surface	۱ ۱ Area	(m^2)	. 8 542	E+3
R	.W	- 111.00	(kN)	: 1.335	E+3
C	w		(/	: 9.414	E-4
S	nip speed hip Speed etted Surface w iw inkage rim at CG		(m)	: -2.458	E-1
Т	rim at CG		(deg)	: -1.754	E-1

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*	SWA	N2 2002	SOLVE		*
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*****	*****	*****	*****	*****	*****
	Name		GRID INFO tsuR083		
	 ae+# ND1	NP2	NP	KP	 МР
5110	eet# NP1 1 6	80	480 1520 660	3	0
	2 19	80	1520	3	0
		12	660	3 3 2 5	1
	4 14 5 14		98 98	5 5	1 1
	6 12			1	0
	PRINC	IPAL HYI	DROSTATIC	PARTICULAR	 S
density	$(kg/m^3) = 10$	025.000	gravity	(m/s^2)=	9.800
	Waterline I	Length	(m)	: 4.134E	2+2
	Waterline E	Beam Seam	(m)	: 4.586E	:+1
	Displacemen	ill nt	(m^3)	· 1.033E	ı+⊥ !+4
	Wetted Suri	ace Are	a (m^2)	: 8.542E	1+3
	LCB (from o	origin)	(m)	: 1.129E	1+2
	TCB (from o	origin)	(m) (m)	4.586E : 1.0334E : 1.334E : 8.542E : 1.129E : 0.000E : -3.536E	:+0
	Waterplane	Area	(m^2)	: 2.520E	i+3
	Metacentri	rigin) Cheight	(m)	: 2.520E : 9.987E : 5.769E	1+1 1+1
	Mass/densit	- V	(KG) (m^3)	1.200E	.+ / !+4
	LCG (from o	origin)	(m)	: 1.113E	- L+2
	TCG (from o	origin)	(m)	: 0.000E	+0
-	VCG (from o	origin)	(m)	: -3.947E	(+0
Rac	ull of Gyrat (about CG)	ıon	(III) : (m) ·	0.000E+0	(LOTT)
	Mass Mass/densit LCG (from of TCG (from of VCG (from of dii of Gyrat (about CG)		(m) :	0.000E+0	(yaw)
		STEADY		RESPONSE	
	Ship Speed		(m/s)	: 7.720E : 1.499E : 8.542E : 1.948E : 7.466E	C+0
	Ship Speed		(knots)	: 1.499E	1+1
	Wetted Surf	ace Are	a (m^2) (kN)	: 8.542E	i+3 '⊥1
	Cw		(1/11/1)	: 7.466E	1-1 1-5
	Sinkage		(m)	: -1.523E	; - I
	Trim at CG		(deg)	: -4.168E	-1

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	Name		GRID INFO tsuR083		
She	eet# NP1 1 6	NP2	NP 222 407 312	KP 3	MP 0
	2 11	37 37 12	407	3 3 2 5	0
	2 11 3 26	12	312	2	1
	4 7	7	49	5	1
	5 7 6 12	7		5 1	1
	6 12	12 	144	т	0
	DRING	 TPAT. HVI	ROSTATIC	PARTICULAR	 S
density	$(kg/m^3) = 10$	25.000	gravity	$(m/s^2) =$	9.800
	Waterline I	ength	(m)	: 4.134E	 E+2
	Waterline E	Beam .	(m)	: 4.585E	E+1
	Maximum Dra	ıft	(m)	: 1.033E	C+1
	Displacemen	it Saga 7 ma	(m ³)	: 1.286E	5+4
	ICB (from c	ace Are	a (III 2) (m)	. 8.421E	1+3 1+2
	TCB (from c	rigin)	(m)	: 0.000E	E+0
	Waterline I Waterline I Maximum Dra Displacemer Wetted Surf LCB (from of TCB (from of VCB (from of	rigin)	(m)	: -3.493E	E+0
	Waterplane LCF (from o				
	LCF (from c	rigin)	(m)	: 1.007E	E+2
	Mass Mass/densit LCG (from of TCG (from of VCG (from of lii of Gyrat (about CG)		(kg)	: 1.200E	G+7
	Mass/densit	У	(m^3)	: 1.171E	E+4
	LCG (from c	rigin)	(m)	: 1.113E	E+2
	VCG (from c	origin)	(III) (m)	3 947	5+0 3+0
Rad	dii of Gyrat	ion	(m) :	0.000E+0	(roll)
	(about CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
		STEADY		RESPONSE	
	Ship Speed		(m/s)	: 1.028E : 1.996E : 8.421E : 4.916E : 1.078E	: :+1
	Ship Speed		(knots)	: 1.996E	E+1
	Wetted Surf	ace Are	a (m^2)	: 8.421E	E+3
	Rw Cw		(kN)	: 4.916E	5+0 7-5
	Sinkage		(m)	: -2.021E	. J I-1
	Trim at CG		(deg)	: -3.262E	3-1

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GRID INFORMATION Name : tsuR083 SSG File Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 55 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
Name : tsuR083 SSG File Sheet# NP1 NP2 NP KP MP
Name : tsuR083 SSG File Sheet# NP1 NP2 NP KP MP
Name : tsuR083 SSG File Sheet# NP1 NP2 NP KP MP
2 19 80 1520 3 0 3 55 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
2 19 80 1520 3 0 3 55 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
2 19 80 1520 3 0 3 55 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$
density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$
Waterline Length (m) : 4.134E+2
Waterline Beam (m) : 4.586E+1
Maximum Draft (m) : $1.033E+1$
Displacement $(m 3)$: 1.334E+4 Wetted Surface Area (m^2) . 8.542E+3
LCB (from origin) (m) : 1.129E+2
TCB (from origin) (m) : 0.000E+0
Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.334E+4 Wetted Surface Area (m^2): 8.542E+3 LCB (from origin) (m): 1.129E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.536E+0
Waterplane Area (m^2) : 2.520E+3 LCF (from origin) (m) : 9.987E+1 Metacentric height (m) : 5.769E+0
LCF (from origin) (m) : 9.987E+1
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 1.113E+2 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw)
$\texttt{Mass/density} \qquad (\texttt{m}^3) : 1.171\texttt{E} + 4$
LCG (from origin) (m): 1.113E+2
VCG (from origin) (m) : -3.947E+0
Radii of Gyration (m) : 0.000E+0 (roll)
(about CG) (m) : $0.000E+0$ (pitch)
(m) : 0.000E+0 (yaw)
STEADY FORCE AND RESPONSE
Ship Speed (m/s) : 1.286E+1
Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1
Wetted Surface Area (m^2) : 8.542E+3
Rw (kN) : 1.553E+2 Cw : 2.145E-4
Sinkage (m) : 2.145E-1
Trim at CG (deg): 1.878E-1

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	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3 3 2 5	0
	2	19	80	1520	3	0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
		DRINCID:	 at. hvi	 DROSTATTC	PARTICULA	 pg
dens	ity (kg/m	^3) = 1025	.000	gravity	(m/s^2) =	9.80
	Wate	rline Len	ath	(m)	. 4.134	 E+2
	Wate	rline Bea	m	(m)	. 4 586	E+1
	Maxi	mum Draft		(m)	. 1.033	E+1
	Dien	lacement	•	(m^3)	. 1 334	E+4
	M¤++ nrsh	ed Surfac	e Are	a (m^2)	. 8 EV.	E+3
	T.CB	(from ori	ain)	(m)	. 1 120	E+2
	TCD	(from ori	gin)	(m)	. 0.000	E+0
	VCB	(from ori	gin)	(m)	: 4.134 : 4.586 : 1.033 : 1.334 : 8.542 : 1.129 : 0.000 : -3.536	E+0
		rnlano Ar		(m^2)	. 2 520	
	wale tar	from or:	ca cirl	(III ∠) (m)	. 4.520	/エ+3 /ロ+1
	MO+ >	CENTRIC P	giah+	(III) (m)	: 2.520 : 9.987 : 5.769	1Ε+ C 12+ T
	meta			(III)	. 5./65	'⊾+U
	Mass			(kg)	: 1.200 : 1.171 : 1.113 : 0.000 : -3.947 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 1.113	E+2
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(trom ori	gin)	(m)	: -3.947	'E+0
	Radii of	Gyration	n	(m) :	0.000E+0	(roll
	(abou	t CG)		(m) :	0.000E+0	(pitcl
				(m) :	0.000E+0	(<u>y</u> a. w
		ST	EADY	FORCE AND	RESPONSE	
		0		(m/s)	: 1.543	E+1
	Ship	Speed				TD . 1
	Ship Ship	Speed Speed		(knots)	: 2.996	P+T
	Ship Ship Wett	Speed Speed ed Surfac	e Are	(knots) a (m^2)	: 2.996 : 8.542	E+1
	Ship Ship Wett Rw	Speed Speed ed Surfac	e Are	(knots) a (m^2) (kN)	: 2.996 : 8.542 : 5.631	E+1 E+3 E+2
	Ship Ship Wett Rw Cw	Speed Speed ed Surfac	e Are	(knots) a (m^2) (kN)	: 2.996 : 8.542 : 5.631 : 5.402	E+1 E+3 E+2 E-4
		STEED Speed Speed ed Surface age at CG	e Are	(knots) a (m^2) (kN)	: 2.996 : 8.542 : 5.631 : 5.402 : 2.239 : 9.241	E+1 E+3 E+2 E-4 E+0

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		Name		GRID INFO	RMATION SSG File	
	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3 3 2 5	0
	2	19	80	1520	3	0
	3	55	12	660	∠ -	1
	4	14	/	96	5	1
	5 6	14 12	1 2	98 144	5 1	1 0
		12		144		
		PRINCIPA	AL HYI	DROSTATIC	PARTICULA	 RS
dens	ity (kg/m	^ 3)= 1025	.000	gravity	$(m/s^2) =$	9.800
	Wate	rline Len	ath	(m)	: 4.134 : 4.586 : 1.033 : 1.334 : 8.542 : 1.129 : 0.000 : -3.536	 !E+2
	Wate	rline Bea	ım	(m)	: 4.586	5E+1
	Maxi	mum Draft	;	(m)	: 1.033	8E+1
	Disp	lacement		(m^3)	: 1.334	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.542	2E+3
	LCB	(from ori	gin)	(m)	: 1.129	9E+2
	TCB	(from ori	gin)	(m)	: 0.000)E+0
	VCB	(from ori	gin)	(m)	: -3.536	E+0
	Wate	rplane Ar	ea	(m^2)	: 2.520)E+3
	LCF	(from ori	gin)	(m)	: 9.987	7E+1
	Meta	centric h	eight	(m)	: 2.520 : 9.987 : 5.769	9E+0
	Magg			(ka)	· 1 200)E+7
	Mass	/density		(m^3)	1.171	E+4
	LCG	(from ori	ain)	(m)	1.113	RE+2
	TCG	(from ori	gin)	(m)	: 0.000)E+0
	VCG	(from ori	gin)	(m)	: -3.947	7E+0
			n ,	(m) ·	0.000E+0	(roll)
	Radii of	GVraLLO				
	Radii of	. Gyracio. t CG)		(m) :	0.000E+0	(pitch
	Mass Mass LCG TCG VCG Radii of (abou	t CG)		(111)	0.000E+0 0.000E+0	(pitch) (yaw)
	Radii of (abou	t CG)		(m) : (m) :	0.000E+0 0.000E+0	(pitch) (yaw)
	Radii of (abou	t CG)		(111)	0.000E+0 0.000E+0	(pitch) (yaw)
	Radii of (abou	t CG)		(111)	0.000E+0 0.000E+0	(pitch) (yaw)
	Radii of (abou			()	0.000E+0 0.000E+0	(pitch (yaw)
		T	EADY	FORCE AND	PRESPONSE	
		T	EADY	FORCE AND	PRESPONSE	
		T	EADY	FORCE AND	PRESPONSE	
		T	EADY	FORCE AND	PRESPONSE	
		T	EADY	FORCE AND	PRESPONSE	
	Ship Ship Wett Rw Cw	ST Speed Speed ed Surfac	EADY	fORCE AND (m/s) (knots) a (m^2) (kN)	: 1.800 : 3.495 : 8.542 : 1.922 : 1.355	 DE+1 DE+1 DE+3 DE+3
	Ship Ship Wette Rw Cw Sinka	T	EADY	fORCE AND (m/s) (knots) a (m^2) (kN)	PRESPONSE	DE+1 DE+1 DE+3 DE+3 DE-3

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				GRID INFO	RMATION SSG File	
She	2 3 4 5 6	NP1 6 19 55 14 14	NP2 80 80 12 7 7 12	NP 480 1520 660 98 98 144	KP 3 3 2 5 5	MP 0 0 1 1 1
density	$(kg/m^3$	() = 1025	.000	gravity	PARTICULAI	9.800
	Waterl Waterl Maximu Displa Wetted LCB (f TCB (f VCB (f	ine Len ine Bea im Draft cement l Surfac from ori from ori	gth m e Are gin) gin)	(m) (m) (m) (m^3) a (m^2) (m) (m) (m)	: 4.134 : 4.421 : 1.033 : 1.606 : 8.291 : 8.023 : 0.000 : -3.549	E+2 E+1 E+1 E+4 E+3 E+1 E+0
	Waterp LCF (f Metace	lane Ar rom ori entric h	ea gin) eight	(m^2) (m) (m)	: 2.896 : 8.556 : 1.640	E+3 E+1 E+1
Rac			gin) gin) gin)	(kg) (m^3) (m) (m) (m) (m):	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0 0.000E+0	E+7 E+4 E+1 E+0 E+0 (roll) (pitch) (yaw)
	Trim a	speed Speed Surfac	e Are	(m/s) (knots) a (m^2) (kN) (m) (deg)	: 7.720 : 1.499 : 8.291 : 7.068 : 2.791 : 3.786 : 1.590	E+0

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*****	******	*****	****	*****	*****	*****
				GRID INFO		
					SSG File	
She	 eet# 1	 JD1	NP2	NP	KP 3 3 2 5	MP
DIIC	1	6	80	480	3	0
	2	19	80	1520	3	0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
	PF	RINCIPA	L HYD	ROSTATIC	PARTICULA	RS
density	(kg/m^3)	= 1025	.000	gravity	(m/s^2) =	9.80
	Waterli	no Ton	~+h	(m)	. / 12/	E+2
	Waterli	ne Bear	m	(m)	: 4.421	E+1
	Maximum	Draft		(m)	: 1.033	E+1
	Displac	ement		(m^3)	: 1.606	E+4
	Wetted	Surfac	e Are	a (m^2)	: 8.291	E+3
	LCB (fr	om ori	gin)	(m)	: 8.023	E+1
	TCB (fr	om ori	gin)	(m)	: 0.000	E+0
	VCB (fr	om ori	gin)	(m)	: 4.421 : 1.033 : 1.606 : 8.291 : 8.023 : 0.000	E+0
	Waternl	ane Ar		(m^2)	. 2896	 E+3
	LCF (fr	om ori	ain)	(m)	8.556	E+1
	Metacen	tric h	eight	(m)	: 2.896 : 8.556 : 1.640	E+1
	Mass			(kg)	: 1.200	E+7
	Mass/de	nsıty .		(m ⁻ ,3)	: 1.171	E+4
	LCG (fr	om ori	gin)	(m)	: 9.929	E+1
	TUG (Tr	om ori	gin)	(m)	: 0.000	E+0
	100 (11	om!	~ + ~ \			
Davi	VCG (fr	om ori	gin)	(m)	0 0000.0	'E+U
Rad	VCG (fr dii of Gy	om ori	gin)	(m) (m) :	0.000E+0	(roll
Rac	VCG (fr dii of Gy (about C	om ori /ration G)	gin) ı	(m) : (m) : (m) :	0.000E+0 0.000E+0	(roli (pito
Rac	VCG (fr dii of Gy (about C	om orion gration G)	gin) 1	(m) (m) : (m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	(roll) (pitc) (yaw
Rac	VCG (fr dii of Gy (about C	om origination	gin)	(m) : (m) : (m) :	0.000E+0 0.000E+0 0.000E+0	(roll (pitc (yaw
Rac	VCG (fr dii of Gy (about C	om orion gration G)	gin)	(m) : (m) : (m) :	0.000E+0 0.000E+0 0.000E+0	(roll (pitc) (yaw
Rac	VCG (fr dii of Gy (about C	om ori /ration G)	gin)	(m) :	0.000E+0 0.000E+0 0.000E+0	(roll) (pitc) (yaw
Rac	VCG (fr dii of Gy (about C				0.000E+0 0.000E+0 0.000E+0	(roll) (pitc) (yaw
Rac		ST	EADY	FORCE AND) RESPONSE	
Rac		ST	EADY	FORCE AND) RESPONSE	
Rac		ST	EADY	FORCE AND) RESPONSE	
Rac		ST	EADY	FORCE AND) RESPONSE	
Rac	Ship Sp Ship Sp Wetted Rw	ST	EADY	FORCE AND	: 1.028 : 1.996 : 8.291 : 4.229	 EE+1 EE+1 EE+3 DE+2
Rac		ST. eed eed surfac	EADY	FORCE AND (m/s) (knots) a (m^2) (kN)) RESPONSE	E+1 E+1 E+3 E+2 E+4

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*****	******	*****	****	*****	*****
			GRID INFO		
				SSG File	
Sh	eet# NP1 1 6 2 19 3 55 4 14	NP2	NP	KP	MP
	1 6	80	480	3 3 2 5	0
	2 19	80	1520	3	0
	3 55	12	660	2	1
	4 14	. 7	98	5	1
	5 14	. 7	98	5	1
	6 12	12	144	1	0
dongitu	PRIN	ICIPAL HY	DROSTATIC	PARTICULA:	RS a onn
	(kg/m ³) = 3				
	Waterline	Length	(m)	: 4.134	E+2
	Waterline	Beam	(m)	: 4.421	E+1
	Maximum D	raft	(m)	: 1.033	8E+1
	Displaceme	ent	(m^3)	: 1.606	E+4
	Wetted Su:	rface Are	a (m^2)	: 8.291	.E+3
	LCB (from	origin)	(m)	: 8.023	8E+1
	TCB (from	origin)	(m)	: 0.000	E+0
	VCB (from	origin)	(m)	: 4.134 : 4.421 : 1.033 : 1.606 : 8.291 : 8.023 : 0.000 : -3.549	E+0
	Waterplane	e Area	(m^2)	: 2.896	E+3
	LCF (from	origin)	(m)	: 8.556	E+1
	Metacentr	ic height	(m)	: 2.896 : 8.556 : 1.640	E+1
			(1)	1 000	
	Mass Magg/dong	i + + + +	(Kg)	: 1.200)E+/
	rass/uells.	rcy	(111 3)	. 1.1/1	. ii + +i . ii - 1
	TCG (IIOM	origin)	(III) (m)	. 9.929) E T U
	VCG (from	origin)	(III) (m)	3 947	7E+0
Da	Mass Mass/dens: LCG (from TCG (from VCG (from dii of Gyra (about CG)	tion	(m) ·	0 0000	(roll)
Ra	(about CG)		(m) ·	0.0005+0	(nitch)
	(about co)		(m) :	0.000E+0	(vaw)
		STEADY	FORCE AND	RESPONSE	
	Ship Speed	 d	(m/s)	: 1.286 : 2.497 : 8.291 : 5.490 : 7.813 : 3.327	 E+1
	Ship Speed	i.	(knots)	2.497	/E+1
	Wetted Su	rface Are	a (m^2)	8.291	E+3
	Rw	LLUCC AIC	(kN)	: 5.490	E+2
	Cw		(1714)	7.813	E-4
	Sinkage		(m)	3.327	7E+0
	Trim at C	3	(dea)	: 3.327 : 1.371	E+0

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******	*****	****	****	*****	*****
	Mama		GRID INFO		
	Name				
Sheet	# NP1	NP2	NP	KP	MP
1	6	80	480	3	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	98	5	1
5	# NP1 6 19 55 14	7	98	5	1
6	12	12	144	1	0
	DRINCIDA	T. HVD	POSTATIC	PARTICULA	
dengity (ko	$1/m^3 = 1025$	חווו ת	aravity	(m/a^2) -	9 800
Wa	terline Lend	qth	(m)	: 4.134	E+2
Wa	terline Bean	n	(m)	: 4.421	E+1
Ма	ximum Draft		(m)	: 1.033	E+1
Di	splacement		(m^3)	: 1.606	E+4
We	tted Surface	e Area	a (m^2)	: 8.291	E+3
LC	B (from orig	gin)	(m)	: 8.023	E+1
TC	B (from orig	gin)	(m)	: 0.000	E+0
VC	terline Lengterline Beam ximum Draft splacement streed Surface (Brom original (From original (Fr	gin)	(m)	: -3.549	E+0
T.T.			(^2)	2.006	п. э
W a	reipiane Are	ta rin)	(III Z)	. 2.090	E+3
Me	terplane Are F (from origitation	aiaht	(III)	. 1.640	E-1
Ma	ss		(kg)	: 1.200	E+7
Ma	ss/density		(m^3)	: 1.171	E+4
LC	G (from orig	gin)	(m)	: 9.929	E+1
TC	G (from orig	gin)	(m)	: 0.000	E+0
VC	ss/density G (from origing (from origing) G (from origing) G (from origing) Of Gyration COUNTY CG)	gin)	(m)	: -3.947	E+0
Radii	of Gyration		(m) :	0.000E+0	(roll)
(ab	out CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	STE	EADY F	FORCE AND	RESPONSE	
Sh	ip Speed ip Speed		(m/s)	: 1.543	E+1
Sh	ip Speed		(knots)	: 2.996	E+1
We	rip Speed Stted Surface	e Area	a (m^2)	: 8.291	E+3
Rw	7		(kN)	: 1.526	E+3
Cw	7			: 1.508	E-3
Si	nkage		(m)	: 5.753 : 2.627	E+0

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	Name	e :	GRID INFO	RMATION SSG File	
Sh.	eet# NP1	NP2	NP	KP	MP
211	1 6	80	480 1520 660	3	0
	2 19	80	1520	3	0
	3 55 4 14	12 7	660	2 5	1 1
	5 14	7	98 98	5	1
	6 12			1	0
	PRINC	CIPAL HY	DROSTATIC	PARTICULARS	 S
density	$(kg/m^3) = 1$				
	Waterline	Length	(m)	: 4.134E : 4.421E : 1.033E : 1.606E : 8.291E : 8.023E : 0.000E : -3.549E	+2
	Waterline	Beam	(m)	: 4.421E	+1
	Maximum Dr	ait nt	(m) (m^2)	: 1.033E	i+⊥ '
	Wetted Sur	nc face Are	(m^2)	: 8.291E	1+4
	LCB (from	origin)	(m)	: 8.023E	+1
	TCB (from	origin)	(m)	: 0.000E	+0
	Waterplane	Area	(m^2)	: 2.896E : 8.556E : 1.640E	1+3
	Metacentri	origin) c height	(m) : (m)	: 8.556E : 1.640E	i+1 i+1
	Mass	+	(kg)	: 1.200E	l+7
	LCG (from	origin)	(m)	· 1.1/1E	+1
	TCG (from	origin)	(m)	: 0.000E	+0
	VCG (from	origin)	(m)	: -3.947E	+0
Ra	dii of Gyrat	ion	(m) :	0.000E+0	(roll)
	Mass Mass/densi LCG (from TCG (from VCG (from dii of Gyrat (about CG)		(m) : (m) :	0.000E+0 (0.000E+0	(yaw)
		STEADY	FORCE AND	RESPONSE	
	Ship Speed		(m/s)	: 1.800E	+1
	Ship Speed	_	(knots)	: 3.495E : 8.291E	+1
	Wetted Sur	tace Are	ea (m^2)	: 8.291E	1+3
	Rw Cw		(kN)	: 1.332E : 9.675E	
	Sinkage		(m)	: 8.369E	
	Trim at CG		(deg)	: 4.156E	

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	Name	:	GRID INFO tsuR073	SSG File	
Sh	eet# NP1 1 6	NP2	NP 480 1520 660 98	KP	MP
	1 6	80	480	3 3 2	0
	2 19 3 55	80	1520	3	0
		12	660	2 5	1
	4 14 5 14	7	98	5	1 1
	6 12	12	144	1	0
	PRINC	IPAL HY	DROSTATIC	PARTICULA	 RS
density	$(kg/m^3) = 10$	25.000	gravity	$(m/s^2) =$	9.800
	Waterline I	Length	(m)	: 4.134	E+2
	Waterline H	Beam	(m)	: 4.421	E+1
	Maximum Dra	aft	(m)	: 1.033	8E+1
	Displacemen	1t 7	(m ³)	: 1.606	E+4
	Wetted Suri	ace Are	a (m 2)	: 8.291	.E+3
	TCB (Irom o	origin)	(III) (m)	9.018	/ E・ U
	Waterline I Waterline I Maximum Dra Displacemen Wetted Surf LCB (from o TCB (from o VCB (from o	origin)	(m)	: -3.549	E+0
	Waterplane	Area	(m^2)	: 2.896	 E+3
	LCF (from o	origin)	(m)	: 9.028	E+1
	Waterplane LCF (from o Metacentrio	c height	(m)	: 1.640	E+1
	Mass Mass/densit LCG (from of TCG (from of VCG (from of dii of Gyrat (about CG)		(kq)	: 1.200)E+7
	Mass/densit	-y	(m^3)	: 1.171	E+4
	LCG (from o	origin)	(m)	: 9.929	E+1
	TCG (from o	origin)	(m)	: 0.000	E+0
	VCG (from o	origin)	(m)	: -3.947	E+0
Ra	dii of Gyrat	ıon	(m) :	0.000E+0 0.000E+0	(roll)
	(about CG)		(m) :	0.000E+0	(pitch) (vaw)
				RESPONSE	
	Ship Speed Ship Speed Wetted Surf Rw Cw		(m/s)	: 7.720	E+0
	Ship Speed		(knots)	: 1.499	E+1
	Wetted Surf	ace Are	a (m^2)	: 8.291	E+3
	Rw		(kN)	: 3.429	E+1
	· · ·				
	Sinkage		(m)	: 2.700	
	Trim at CG		(deg)	: 8.359	ъ-Т

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			(GRID INFO	RMATION	
	Na	ame	:	tsuR073	SSG Fil	е
Sh	eet# NI 1	21	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3 3 2	0
	2 1	L9 55	80	1520	3	0
		5	12	660	2	1
		L4 L4	7	98	5 5	т.
		L4 L2	12	144	1	0
density	PRI (kg/m^3)=	NCIPAL 1025.	J HYD	ROSTATIC gravity	PARTICU (m/s^2):	LARS = 9.800
	Waterlin	e Leng	tn	(m)	: 4	L34E+2
	Marinin	e Beam Draft		(III) (m)	: 4.4	±∠⊥Ľ+⊥ \>>©:1
	Displace	ment		(m^3)	. 1.0	506E+4
	Wetted S	urface	Area	(m^2)	. 8.1	291E+3
	LCB (fro	m orig	in)	(m)	: 9.0	018E+1
	TCB (fro	m orig	in)	(m)	: 0.0	000E+0
	Waterlin Maximum Displace Wetted S LCB (fro TCB (fro VCB (fro	m orig	in)	(m)	: -3.5	549E+0
	Waterpla	ne Are	a	(m^2)	: 2.8	 396E+3
	LCF (fro	m orig	in)	(m)	: 9.0	028E+1
	Metacent	ric he	ight	(m^2) (m) (m)	: 1.6	540E+1
	Mass Mass/den LCG (fro TCG (fro VCG (fro dii of Gyn (about CG			(kg)	: 1.2	200E+7
	Mass/den	sity		(m^3)	: 1.	171E+4
	LCG (fro	m orig	in)	(m)	: 9.9	929E+1
	TCG (fro	m orig	in)	(m)	: 0.0	000E+0
	VCG (fro	m orig	in)	(m)	: -3.9	947E+0
Ra	dii of Gyi	ation		(m) :	0.000E	+0 (roll) +0 (pitch)
	(about CG)		(m) :	U.U00E-	+U (pitch)
				(m) :	0.0001	±+0 (yaw)
				FORCE AND		
	Ship Spe	ed		(m/s) (knots) a (m^2) (kN)	: 1.0	028E+1
	Ship Spe	ed		(knots)	: 1.9	996E+1
	Wetted S	urface	Area	a (m^2)	: 8.2	291E+3
	Rw			(kN)	: 4.4	110E+2
				/ \	: 9.8	
	Sinkage	CC		(m)	: 3.1	176E+0
	Trim at	CG		(deg)	: 1.0	065E+0

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* Massachusetts Institute of Technology * * ********************************	*	SW	AN2 2002	SOLVE		*
* Massachusetts Institute of Technology * * ********************************	*					*
### CRID INFORMATION Name	*	C	opyright	(C) 2002		*
Sheet# NP1 NP2 NP KP MP	*	Massachuse	tts Inst	itute of '	Technology	*
Name	*******	*****	*****	*****	*****	*****
Name						
Sheet# NP1 NP2 NP KP MP 1 6 80 480 3 0 2 19 80 1520 3 0 3 555 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.421E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 9.018E+1 TCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : -3.549E+0 Waterplane Area (m^3) : 1.71E+4 LCG (from origin) (m) : 9.028E+1 Metacentric height (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (roll) (bout CG) (m) : 0.000E+0 (roll) (cabout CG) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots) : 2.497E+1 Wetted Surface Area (m^2) : 8.291E+3 Rw (kN) : 2.494E+2 Cw : 3.550E-4 Sinkage (m) : 2.954E+0				GRID INFO	RMATION	
1 6 80 480 3 0 2 19 80 1520 3 0 3 555 12 660 2 1 4 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.421E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 9.018E+1 TCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : -3.947E+0 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : 2.947E+1 Wetted Surface Area (m^2) : 8.291E+3 RW (kN) : 2.497E+1 Wetted Surface Area (m^2) : 8.291E+3 RW (kN) : 2.494E+2 CW : 3.550E-4 Sinkage (m) : 2.954E+0		Nam	e :	tsuR073	SSG File	
2 19 80 1520 3 0 3 55 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) 4.134E+2 Waterline Beam (m) 4.421E+1 Maximum Draft (m) 1.033E+1 Displacement (m'3) 1.606E+4 Wetted Surface Area (m'2) 8.291E+3 LCB (from origin) (m) 9.018E+1 TCB (from origin) (m) 1.030E+0 VCB (from origin) (m) 1.640E+1 Waterplane Area (m'2) 2.896E+3 LCF (from origin) (m) 1.640E+1 Mass (kg) 1.200E+7 Mass/density (m'3) 1.171E+4 LCG (from origin) (m) 9.929E+1 TCG (from origin) (m) 9.929E+1 TCG (from origin) (m) 1.000E+0 VCG (from origin) (m) 1.3947E+0 Radii of Gyration (m) 0.000E+0 (pitch) (xg) (from origin) (m) 1.000E+0 (pitch) (xg) (from origin) (xg) 1.286E+1 Ship Speed (knots) 1.286E+1 Ship Speed (knots) 2.497E+1 Wetted Surface Area (m'2) 8.291E+3 RW (kN) 2.494E+2 CW 3.550E-4 Sinkage (m) 1.2954E+0	She	et# NP1	NP2	NP	KP	
## 14		1 6	80	480	3	
## 14		2 19	12	1520	3	
Strady Force And Response Ship Speed (km/s) : 1.286E+1			7	98	5	
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.21E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 9.018E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : 9.028E+1 Metacentric height (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : -3.947E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots) : 2.497E+1 Wetted Surface Area (m^2) : 8.291E+3 Rw (kN) : 2.494E+2 Cw : 3.550E-4 Sinkage (m) : 2.954E+0			7	98	5	
Waterline Length		6 12	12		1	0
Waterline Length						
Waterline Length						
Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.421E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 9.018E+1 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.549E+0 Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 (xG) (from origin) (m): 0.000E+0 (roll) (xB) (xB) (xB) (xB) (xB) (xB) (xB) (xB)	density	$(kg/m^3) = 1$.025.000	gravity	$(m/s^2) =$	9.800
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 RW (kN): 2.494E+2 CW : 3.550E-4 Sinkage (m): 2.954E+0		Waterline	Length	(m)	: 4.134E	1+2
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 RW (kN): 2.494E+2 CW : 3.550E-4 Sinkage (m): 2.954E+0		Waterline	Beam	(m)	: 4.421E	1+1
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Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 RW (kN): 2.494E+2 CW : 3.550E-4 Sinkage (m): 2.954E+0		Displaceme	ent	(m^3)	: 1.606E	1+4
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 RW (kN): 2.494E+2 CW : 3.550E-4 Sinkage (m): 2.954E+0		Wetted Sur	riace Are	a (m 2)	: 8.291E	i+3 '⊥1
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 RW (kN): 2.494E+2 CW : 3.550E-4 Sinkage (m): 2.954E+0		TCB (from	origin)	(m)	: 0.000E	1+0
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 9.028E+1 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): 0.000E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 RW (kN): 2.494E+2 CW : 3.550E-4 Sinkage (m): 2.954E+0		VCB (from	origin)	(m)	: -3.549E	2+0
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (m/s) : 1.286E+1 Ship Speed (knots) : 2.497E+1 Wetted Surface Area (m^2) : 8.291E+3 RW (kN) : 2.494E+2 CW : 3.550E-4 Sinkage (m) : 2.954E+0						
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (m/s) : 1.286E+1 Ship Speed (knots) : 2.497E+1 Wetted Surface Area (m^2) : 8.291E+3 RW (kN) : 2.494E+2 CW : 3.550E-4 Sinkage (m) : 2.954E+0		LCF (from	origin)	(m)	: 9.028E	+1
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE Ship Speed (m/s) : 1.286E+1 Ship Speed (knots) : 2.497E+1 Wetted Surface Area (m^2) : 8.291E+3 RW (kN) : 2.494E+2 CW : 3.550E-4 Sinkage (m) : 2.954E+0						
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0		Mass		(kg)	: 1.200E	 :+7
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0		Mass/densi	.ty	(m^3)	: 1.171E	+4
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0		LCG (from	origin)	(m)	: 9.929E	1+1
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0		VCG (from	origin)	(M) (m)	: U.UUUE	ı+∪ !+∩
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0	Rad	ii of Gvra	tion	(m) :	0.000E+0	(roll)
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0		(about CG)		(m) :	0.000E+0 (pitch)
STEADY FORCE AND RESPONSE Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0				(m) :	0.000E+0	(yaw)
Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0						
Ship Speed (m/s): 1.286E+1 Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0						
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Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0			STEADY	FORCE AND	RESPONSE	
Ship Speed (knots): 2.497E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 2.494E+2 Cw : 3.550E-4 Sinkage (m): 2.954E+0		Ship Speed	 l	(m/s)	: 1.286E	 :+1
Cw : 3.550E-4 Sinkage (m) : 2.954E+0		Ship Speed	l	(knots)	: 2.497E	1+1
Cw : 3.550E-4 Sinkage (m) : 2.954E+0		Wetted Sur	face Are	a (m^2)	: 8.291E	1+3
Sinkage (m) : 2.954E+0				(kN)	. 2.1711	2
				(m)		
Trim at CG $(deg): 1.067E+0$		Trim at CO	1	(deg)		

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Sheet#	NP1	NP2	NP 480 1520 660 98 98	KP	MP
1	6	80	480	3	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	98	5 5	1
5	14	7	98	5	1
6	12	12	144	1	0
	PRINCIPA	L HYI	ROSTATIC	PARTICULA	RS
density (kg/r	n^3) = 1025	.000	gravity	$(m/s^2) =$	9.800
Wate	erline Leng	gth	(m)	: 4.134	E+2
Wate	erline Bear	n	(m)	: 4.421	.E+1
Max.	lmum Drait		(III) (m^2)	1.033	E-1
Met t	ed Surface	a Are	a (m^2)	. 8 291	ET3
I ₁ CB	(from orio	gin)	(m)	9.018	RE+1
TCB	(from orio	gin)	(m)	: 0.000	E+0
VCB	(from original	gin)	(m)	: 4.134 : 4.421 : 1.033 : 1.606 : 8.291 : 9.018 : 0.000 : -3.549	E+0
Wate	erplane Are	ea	(m^2)	: 2.896 : 9.028 : 1.640	E+3
LCF	(from orig	gin)	(m)	: 9.028	BE+1
Mace			(ka)	. 1 200)F+7
Mass	s/densitv		(m^3)	: 1.171	E+4
LCG	(from orio	gin)	(m)	: 9.929	E+1
TCG	(from orio	gin)	(m)	: 0.000	E+0
VCG	(from orig	gin)	(m)	: -3.947	'E+0
Radii o	f Gyration	L	(m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	(roll)
(aboı	ıt CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	ST	EADY	FORCE AND	RESPONSE	
Shir	Speed		(m/s)	: 1.543 : 2.996 : 8.291 : 3.560 : 3.519	E+1
Ship	Speed	-	(knots)	: 2.996	E+1
Wett	cea Surtace	e Are	a (m 2)	: 8.291	.E+3
RW Ct.:			(KN)	: 3.560) E + ∠) E _ /I
CW	kage		(m)	. 3.515) E T U
	nat CG		(dea)	: -1.369 : -9.711	E-1

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	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3 3 2 5	0
	2	19	80	1520	3	0
	3	55	12	660	2	1
	4	14	./	98	5	1
	5	14	7	98	5	1
	6 	12	12	144	1	0
		DRINCID:	 at. hvi		PARTICULA	 pg
densi	ty (kg/m [°]	^3) = 1025	5.000	gravity	$(m/s^2) =$	9.800
					(m/s^2) =	
	Wate:	rline Len	igth	(m)	: 4.134	E+2
	wate:	riine Bea	ım	(m)	: 4.421	LE+I
	Maxi	num Drait	•	(111)	1.033	5E+1
	Disp.	lacement	7	(m 3)	: 1.606	E+4
	wette	ed Suriac	e Are	a (m 2)	: 8.291	LE+3
	TCD	(from ori	.gin)	(III) (m)	. 9.016) L · U
	VCB	(from ori	.gin) .gin)	(III) (m)	: 4.134 : 4.421 : 1.033 : 1.606 : 8.291 : 9.018 : 0.000 : -3.549	9E+0
	Wate:	rplane Ar	rea	(m^2)	: 2.896	5E+3
	LCF	(from ori	.gin)	(m)	: 9.028	3E+1
	Meta	centric h	neight 	(m)	: 2.896 : 9.028 : 1.640)E+1
	Mass			(kg)	: 1.200 : 1.171 : 9.925 : 0.000 : -3.947 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 9.929	9E+1
	TCG	(from ori	.gin)	(m)	: 0.000)E+0
	VCG	(from ori	.gin)	(m)	: -3.947	7E+0
	Radii of	Gyration	n	(m) :	0.000E+0	(roll)
	(about	t CG)		(m) :	0.000E+0	(pitch)
				(m) :	0.000E+0) (yaw)
					RESPONSE	
			 EADY	FORCE AND	RESPONSE	
			 EADY	FORCE AND)E+1
			 EADY	FORCE AND)E+1 5E+1
			 EADY	FORCE AND		DE+1 DE+1 DE+3
			 EADY	FORCE AND)E+1 5E+1 LE+3 9E+2
	Ship Ship Wettc Rw Cw	Speed Speed ed Surfac	EADY	FORCE AND (m/s) (knots) a (m^2) (kN)	: 1.800 : 3.495 : 8.291 : 5.439 : 3.951	 DE+1 5E+1 LE+3 DE+2 LE-4
	Ship Ship Wett Rw Cw Sink		EADY	FORCE AND (m/s) (knots) a (m^2) (kN)	: 1.800 : 3.495 : 8.291 : 5.435 : 3.951 : -3.433	DE+1 DE+1 LE+3 DE+2 LE-4 BE+0

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** Massachusetts Institute of Technology ** *********************************	*	SWA	N2 2002	SOLVE		*
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Sheet# NP1 NP2 NP KP MP	*	Massachuset	ts Inst	itute of '	Technology	*
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Name						
1		Name	:	GRID INFO	RMATION SSG File	
1	She	et# NP1	NP2	NP	KP	MP
2 19 80 1520 3 0 3 55 12 660 2 1 4 14 7 98 5 1 5 14 7 98 5 1 6 12 12 144 1 0 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.421E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 1.113E+2 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : 1.003E+2 Metacentric height (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (pitch)		1 6	80	480	3	0
FRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.421E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 1.113E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.549E+0 Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 9.929E+1 TCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		2 19	80	1520	3	
FRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.421E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 1.113E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.549E+0 Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 9.929E+1 TCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)			12	660	2	
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.421E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 1.113E+2 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : 1.003E+2 Metacentric height (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw)			7	98	5	
density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.421E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : 1.003E+2 Metacentric height (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (pitch) (about CG) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE						
density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.421E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0 Waterplane Area (m^2) : 2.896E+3 LCF (from origin) (m) : 1.003E+2 Metacentric height (m) : 1.640E+1 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (pitch) (about CG) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE						
Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.421E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 1.113E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.549E+0 Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 9.929E+1 TCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		PRINC	IPAL HYI	DROSTATIC	PARTICULARS	 3
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE	density					
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		Waterline I	Length	(m)	: 4.134E	+2
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		Waterline H	3eam	(m)	: 4.421E	+1
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		Maximum Dra	alt n+	(m^3)	: 1.033E	+1 +1
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw) STEADY FORCE AND RESPONSE		Wetted Suri	ic Face Are	a (m^2)	: 8.291E	+3
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		LCB (from o	origin)	(m)	: 1.113E	+2
Waterplane Area (m^2): 2.896E+3 LCF (from origin) (m): 1.003E+2 Metacentric height (m): 1.640E+1 Mass (kg): 1.200E+7 Mass/density (m^3): 1.171E+4 LCG (from origin) (m): 9.929E+1 TCG (from origin) (m): 0.000E+0 VCG (from origin) (m): -3.947E+0 Radii of Gyration (m): 0.000E+0 (roll) (about CG) (m): 0.000E+0 (pitch) (m): 0.000E+0 (yaw)		TCB (from o	origin)	(m)	: 0.000E	+0
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw)						
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw)		Waterplane	Area	(m^2)	: 2.896E	+3
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw)		LCF (from o	origin)	(m)	: 1.003E	+2
STEADY FORCE AND RESPONSE						
STEADY FORCE AND RESPONSE		Mass		(kg)	: 1.200E	+7
STEADY FORCE AND RESPONSE		Mass/densit	zy	(m^3)	: 1.171E	+4
STEADY FORCE AND RESPONSE		TCG (from a	origin)	(III) (m)	. 9.929E	+1
STEADY FORCE AND RESPONSE		VCG (from o	origin)	(m)	: -3.947E	+0
STEADY FORCE AND RESPONSE	Rad	lii of Gyrat	ion	(m) :	0.000E+0	(roll)
STEADY FORCE AND RESPONSE		(about CG)		(m) :	0.000E+0 (pitch)
						.yaw,
			STEADY			
Ship Speed (m/s): 7.720E+0 Ship Speed (knots): 1.499E+1 Wetted Surface Area (m^2): 8.291E+3 Rw (kN): 8.058E+1 Cw : 3.182E-4		Ship Speed		(m/s)	: 7.720E	+0
Ship Speed (m/s): 7.720E+0 Ship Speed (knots): 1.499E+1		Ship Speed		(knots)	: 1.499E	+1
Wetted Surface Area (m^2) : 8.291E+3		Wetted Suri	face Are	a (m^2)	: 8.291E	+3
Rw (kN) : 8.058E+1				(kN)	: 8.058E	+1
Cw : 3.182E-4 Sinkage (m) : -2.234E+0				(m)	: 3.182E	-4 +0
Trim at CG (deg): -2.075E+0				(deg)	: -2.075E	+0

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			GRID INFO		
	Name			SSG File	
Sh	eet# NP1	NP2	NP	KP	MP
	1 6	80	480	3 3 2 5	0
	2 19	80	1520	3	0
	3 55	12	660	2	1
	4 14	7	98	5	1
	eet# NP1 1 6 2 19 3 55 4 14 5 14	7	98	5	1
	6 12	12	144	1	0
	PRINCIE	PAL HYI	DROSTATIC	PARTICULA	RS
density	(kg/m ³) = 102	5.000	gravity	$(m/s^2) =$	9.800
	Waterline Le	ngth	(m)	: 4.134	E+2
	Waterline Be	am	(m)	: 4.421	.E+1
	Maximum Draf	t	(m)	: 1.033	E+1
	Displacement		(m^3)	: 1.606	E+4
	Wetted Surfa	ce Are	a (m^2)	: 8.291	.E+3
	LCB (from or	igin)	(m)	: 1.113	E+2
	TCB (from or	igin)	(m)	: 0.000	E+0
	Waterline Le Waterline Be Maximum Draf Displacement Wetted Surfa LCB (from or TCB (from or VCB (from or	igin)	(m)	: -3.549	E+0
	Waterplane A	roo	(m^2)	. 2 006	
	Waterplane A LCF (from or Metacentric	iain)	(III Z)	. 2.000	E-2
	Metacentric	height	(III)	. 1.003	1E+2
	Mass Mass/density LCG (from or TCG (from or VCG (from or dii of Gyratic (about CG)		(kg)	: 1.200	E+7
	Mass/density		(m^3)	: 1.171	E+4
	LCG (from or	igin)	(m)	: 9.929	E+1
	TCG (from or	igin)	(m)	: 0.000	E+0
	VCG (from or	igin)	(m)	: -3.947	'E+0
Rad	dii of Gyratio	on	(m) :	0.000E+0	(roll)
	(about CG)		(m) :	0.000E+0	(pitch)
			(111)	0.000E+0	(yaw)
	S	TEADY	FORCE AND	RESPONSE	
	Ship Speed Ship Speed Wetted Surfa Rw Cw		(m/s)	: 1.028	E+1
	Ship Speed		(knots)	: 1.996	E+1
	Wetted Surfa	ce Are	a (m^2)	: 8.291	E+3
	Rw		(kN)	: 4.672	E+2
	Cw			: 1.041	E-3
	Sinkage		(m)	: -1.640 : -1.750	E+0
	Trim at CG				

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				GRID INFO		
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	Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3	0
	2	19	80	1520	3 3 2 5	0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
		DRINCID:	 at, hvi	POSTATIC	PARTICULA	 RS
dens	ity (kg/m	^3) = 1025	.000	gravity	(m/s^2) =	9.80
	Wate	rline Len	at.h	(m)	: 4.134 : 4.421 : 1.033 : 1.606 : 8.291 : 1.113 : 0.000 : -3.549	 E+2
	Wate	rline Bea	m	(m)	. 4 421	F±1
	Maxi	mum Draft		(m)	. 1 033	E+1
	Dien	a Drait		(m^3)	. 1.033	E+4
	Me++ preh	ed Surfac	e Are	a (m^2)	. 8 291	E+3
	I'GB	(from ori	ain)	(m)	. 0.231	E+2
	TCD	(from ori	ain)	(m)	. 0.000	E+0
	VCB	(from ori	gin)	(m)	: -3.549	E+0
	TVI a to	rnlano Ar		(m^2)	. 2000	
	wale T.CF	(from ori	ca cinl	(III ∠) (m)	. 4.090	E+3
	ДСР Мо+о	centric h	giii) Saidht	(III) (m)	: 2.896 : 1.003 : 1.640	1⊑+∠ 1⊑±1
	меса	centric n	 eraiir	(111)	. 1.640	
	Mass			(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0	E+7
	Mass	/density		(m^3)	: 1.171	.E+4
	LCG	(from ori	gin)	(m)	: 9.929	E+1
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	E+0
	Radii of	Gyration	n	(m) :	0.000E+0	(roll
	(abou	t CG)		(m) :	0.000E+0	(pitc
				(m) :	0.000E+0	(<u>y</u> a. w
		ST	EADY	FORCE AND	RESPONSE	
	Chin	Speed		(m/s)	: 1.286	E+1
	SIIID			(knots)	: 2.497	'E+1
	Ship	Speed				
	Ship Ship Wett	Speed ed Surfac	e Are	a (m^2)	: 8.291	E+3
	Ship Ship Wett Rw	Speed ed Surfac	e Are	a (m^2) (kN)	: 8.291 : 5.387	E+3 'E+2
	Ship Ship Wett Rw Cw	Speed ed Surfac	e Are	a (m^2) (kN)	: 8.291 : 5.387 : 7.666	E+3 'E+2 E-4
	Ship Ship Wett Rw Cw Sink	ST Speed Speed ed Surfac	e Are	a (m^2) (kN)	: 8.291 : 5.387 : 7.666 : -2.495 : -2.056	E+3 E+2 E-4 E+0

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		G	RID INFO	RMATION	
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Sh	eet# NP1	NP2		KЪ	MP
	1 6	37	222	3	0
	2 11 3 26	37 37 12	NP 222 407 312	3 3 2 5	0
	3 26	12	312	2	1
	4 7	7	49 49	5	1
	5 7	7		5	1
	6 12	12	144	1	0
density	$(kg/m^3) = 102$	5.000	gravity	PARTICULAR (m/s^2) =	9.800
	Waterline Le	119 [11	(III) (m)	: 4.134	⊡+∠ ⊡.1
	Marimum Drof	alli +	(III) (m)	. 4.42U	⊡+⊥ R⊥1
	Displacement	C	(m^3)	. 1.033	⊔т⊥ Е+4
	Wetted Surfa	ce Area	(m^2)	. 2.347	E+3
	LCB (from or	igin)	(m)	: 1.117	E+2
	TCB (from or	igin)	(m)	: 0.000	E+0
	Waterline Le Waterline Be Maximum Draf Displacement Wetted Surfa LCB (from or TCB (from or VCB (from or	igin)	(m)	: -3.513	E+0
	Waternlane A	rea	(m^2)	. 2 805	ET3
	LCF (from or	iain)	(m)	. 2.005	E+2
	Waterplane A LCF (from or Metacentric	height	(m)	: 1.478	E+1
	Mass		(kg)	: 1.200	E+7
	mass/density	١ ١ - ١	(m 3)	: 1.171	Ľ+4
	LCG (from or	igin)	(m)	: 1.115	E+2
	VCG (from or	igin)	(III) (m)	2 0/7	E+0 ⊡+0
Da	dii of Gyrati	Ju TATII)	(m) •	0 000ETU	(roll
Ka	(about CG)	(m) ·	0.000E+0	(pitch
		`	(m) :	0.000E+0	(yaw)
	Mass/density LCG (from or TCG (from or VCG (from or dii of Gyratic				
			OD CE 737		
				RESPONSE	
	Ship Speed Ship Speed		(m/s)	: 1.543	E+1
	Ship Speed	(knots)	: 2.996	E+1
	Wetted Surfa	ce Area	(m^2)	: 2.996 : 8.184 : 7.152 : 7.162	E+3
	Rw		(kN)	: 7.152	E+2
	Cw		, ,	: 7.162	E-4
	Sinkage		(m)	: 1.921 : 4.682	Ŀ+0
	Trim at CG				

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	Nama		GRID INFO		
				SSG File	
Sheet#	NP1	NP2	NP	KP	MP
1	6	80	480	3	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	98	5 5	1
5	14	7	NP 480 1520 660 98 98	5	1
6	12	12	144	1	0
	PRINCIPA	L HYI	ROSTATIC	PARTICULA	RS
density (kg/	n^3) = 1025	.000	gravity	$(m/s^2) =$	9.800
Wate	erline Lengerline Beat imum Draft placement ted Surface (from orio (from orio	gth	(m)	: 4.134	E+2
Wate	erline Bear	n	(m)	: 4.421	E+1
Max	ımum Draft		(m)	: 1.033	3E+1
Dis	olacement	2 7 200	(m 3)	: 1.606	E+4
T.CD	from ori	zin)	a (III 2)	. 0.291	.E+3
TCB	(from original	rin)	(m)	. 0.000)E+0
VCB	(from original	gin)	(m)	: -3.549	E+0
Wate	erplane Are	ea	(m^2)	: 2.896	E+3
LCF	(from original	gin)	(m)	: 1.003	3E+2
Meta	erplane Are (from orig acentric he	eight	(m)	: 1.640	E+1
Magu	~		(1-~)	. 1 200	
Mas:	s/dengity		(m^3)	. 1.200	E+4
T.CC	(from oria	ain)	(m)	. 9 920	E+1
TCG	(from original	gin)	(m)	: 0.000	E+0
VCG	s/density (from original (from original (from original (from original (from original)	gin)	(m)	: -3.947	E+0
Radii c	f Gyration	Ĺ	(m) :	0.000E+0	(roll)
(aboı	ut CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0) (yaw)
	ST	EADY	FORCE AND	RESPONSE	
Shij	o Speed o Speed ted Surface		(m/s)	: 1.800	E+1
Shi	Speed		(knots)	: 3.495	E+1
Wet	ted Surface	e Are	a (m^2)	: 8.291	E+3
Rw			(KN)	: 1.527	/E+3
CW			/ \	: 1.110	. E・O
	kage		(m)	: 4.996 : 1.907	7E+0
	n at CG				

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*	*****				*
****	*****	*****	*****	*****	*****
			GRID INFO	RMATION	
	Name			SSG File	
Sh	eet# NP1 1 6 2 19 3 55 4 14 5 14	NP2	NP	KP	MP
	1 6	80	480	3 3 2 5	0
	2 19	80	1520	3	0
	3 55	12	660	2	1
	4 14	7	98	5	1
	5 14	7	98	5	1
	6 12	12	144	1	0
	PRINCI	PAL HYI	ROSTATIC	PARTICULA	RS
density	(kg/m ³) = 102	25.000	gravity	$(m/s^2) =$	9.800
	Waterline Le	engtn	(m)	: 4.134	E+2
	Waterline Be	eam	(m)	: 4.586	E+1
	Maximum Dra	Εt	(m)	: 1.033	E+T
	Displacement	ī,	(m ³)	: 1.606	E+4
	wetted Suria	ace Are	a (m 2)	: 8.291	.E+3
	LCB (from o	rigin)	(m)	: 8.023	E+1
	TCB (from o	rigin)	(m)	: 0.000)E+0
	Waterline Le Waterline Be Maximum Dra: Displacement Wetted Surfa LCB (from o: TCB (from o: VCB (from o:	r191n)	(111)	: -3.549	/比+U
	Waterplane A LCF (from or Metacentric	Area	(m^2)	: 2.896	E+3
	LCF (from o	rigin)	(m)	: 8.556	E+1
	Metacentric	height	(m)	: 1.753	E+1
	Mass Mass/density LCG (from o: TCG (from o: VCG (from o: dii of Gyrati (about CG)		(kg)	: 1.200	E+7
	Mass/density	Y	(m^3)	: 1.171	E+4
	LCG (from o	rigin)	(m)	: 9.929	E+1
	TCG (from o	rigin)	(m)	: 0.000	E+0
	VCG (from o	rígin)	(m)	: -3.947	'E+0
Rad	dii of Gyrati	on	(m) :	0.000E+0	(roll)
	(about CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	\$	STEADY	FORCE AND	RESPONSE	
	Ship Speed Ship Speed Wetted Surfa Rw Cw Sinkage		(m/q)	· 7 720	 E+0
	Ship Speed		(knots)	1.499	E+1
	Wetted Surf	ace Are	a (m^2)	. 8 291	E+3
	Rw	ASC ALC	(kN)	7.092	E+1
	Cw		(1714)	2.801	E-4
	Sinkage		(m)	3.796	E+0
	Trim at CG		(dea)	: 3.796 : 1.596	E+0

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*		a				
*		SWAN2	2002	SOLVE		
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		27		GRID INFO		
					SSG File	
Sh	eet#	NP1	NP2	NP 480 1520 660 98	KP	MP
	1	6	80	480	3 3 2 5	0
	2	19	80	1520	3	0
	3	55	12	660	2	1
	4	14	./	98	5	1
	5	14	.7	98	5	1
	6	12	12	144	1	0
donaitu	/1r~/m^	PRINCIPA 1025	AL HYI	OROSTATIC	PARTICULA:	RS 0 000
delisity	(Kg/III	3)= 1023		gravity	(m/s^2) =	9.600
	Water	line Len	igth	(m)	: 4.134	E+2
	Water	line Bea	ım	(m)	: 4.586	5E+1
	Maxim	um Draft	;	(m)	: 1.033	8E+1
	Displ	acement		(m^3)	: 1.606	E+4
	Wette	d Surfac	e Are	a (m^2)	: 8.291	LE+3
	LCB (trom ori	.gin)	(m)	: 8.023	3E+1
	TCB (from ori	gin)	(m)	: 4.134 : 4.586 : 1.033 : 1.606 : 8.291 : 8.023 : 0.000 : -3.549)E+()
	v CB (.A TII)	(111)	3.545	 /⊡+∪
	Water	plane Ar	ea	(m^2)	: 2.896	E+3
	LCF (from ori	gin)	(m)	: 8.556	5E+1
	Metac	entric h	neight	(m)	: 2.896 : 8.556 : 1.753	8E+1
	Magg			(ka)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0) F + 7
	Magg/	dengitu		(KG)	. 1.200	/E+/
	T.CC /	trom ori	ain)	(m)	. 9 920)F.1
	TCG (from ori	gin)	(m)	. 0.000)E+0
	VCG (from ori	gin)	(m)	: -3.947	7E+0
Ra	dii of	Gyratio	n,	(m) :	0.000E+0	(roll)
110	(about	ĆG)		(m) :	0.000E+0	(pitch)
		-		(111)	0.000E+0	(yaw)
		SI	EADY	FORCE AND	RESPONSE: 1.028: 1.996: 8.291: 3.977: 8.858: 3.735	
	ak			/		
	Snip	speed		(m/s)	: 1.028	5E+1
	snip	speed	7	(Knots)	: 1.996	E+T
	wette	u suriac	e are	(M ∠)	: 8.291	15+3
	Ct.			(KIN)	: 3.9//	/ Ľ+∠ 2 ፫ _ /
	Cw Sinba	ge		(m)	. 0.000	ΣΕΤU -4
	Trim	ge at CG		(dea)	: 3.735 : 1.591	E+0
					. 1.591	

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*	SWAN2	2002	SOLVE		*
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			anth the	DMARITON	
	Name		GRID INFO		
				SSG File	
Sheet#	NP1	NP2	NP 480 1520 660 98	KP	MP
1	6	80	480	3	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	98	5 5	1
5	14	7	98	5	1
6	12	12	144	1	0
	PRINCIPA	L HYD	ROSTATIC	PARTICULA	RS
density (kg/r	n^3) = 1025	.000	gravity	$(m/s^2) =$	9.800
Wate	erline Len	gth	(m)	: 4.134 : 4.586 : 1.033 : 1.456 : 8.411 : 8.847 : 0.000 : -3.543	E+2
Wate	erline Beai	m	(m)	: 4.586	E+1
Max	lmum Drait		(m) (^2)	1.033	5E+1
DIS	od Surface	0 7 20	(III 3)	. 1.456	15年4
T.CB	from ori	e Aleo	a (III 2) (m)	. 8.411	. 丘+3 7〒11
TCB	(from original	gin)	(m)	. 0.000)E+0
VCB	(from original	gin)	(m)	: -3.543	E+0
Wate	erplane Ar	ea	(m^2)	: 2.690	E+3
LCF	(from original	gin)	(m)	: 9.214	E+1
Meta	acentric h	eight	(m)	: 2.690 : 9.214 : 1.105	E+1
Mag			(150)	. 1 200	
Mag	s/densitv		(m^3)	1.171	E+4
I.CG	(from orio	ain)	(m)	9.929	E+1
TCG	(from original	gin)	(m)	: 0.000)E+0
VCG	(from ori	gin)	(m)	: -3.947	'E+0
Radii o	f Gyration	1	(m) :	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	(roll)
(aboı	ıt CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
				RESPONSE	
Shir	Speed		(m/s)	: 1.286 : 2.497 : 8.411 : 3.729 : 5.230 : 3.032	E+1
Shir	Speed	_	(knots)	: 2.497	E+1
Wett	ed Surfac	e Area	a (m^2)	: 8.411	.E+3
Rw			(KN)	: 3.729	7E+2
CW C4ml			(m)	: 5.230) D - 4
D7111	rage n at CG		(dea)	: 3.032 : 1.295	E0
			(405)	: 1.295	

2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): -3.549E+0 VCB (from origin) (m): -3.549E+0	MP 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
* Massachusetts Institute of Technology * **********************************	MP 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
* Massachusetts Institute of Technology * **********************************	MP 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
GRID INFORMATION Name : tsuR075 SSG File Sheet# NP1 NP2 NP KP M 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	MP 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
GRID INFORMATION Name : tsuR075 SSG File Sheet# NP1 NP2 NP KP M 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	MP 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Name : tsuR075 SSG File Sheet# NP1 NP2 NP KP M 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	0 0 1 1 0
Sheet# NP1 NP2 NP KP M 1 6 80 480 3 2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	0 0 1 1 0
2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): -3.549E+0 VCB (from origin) (m): -3.549E+0	0 0 1 1 0
2 19 80 1520 3 3 55 12 660 2 4 14 7 98 5 5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): -3.549E+0 VCB (from origin) (m): -3.549E+0	0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): -3.549E+0 VCB (from origin) (m): -3.549E+0	1 1 0 0
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): -3.549E+0 VCB (from origin) (m): -3.549E+0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
5 14 7 98 5 6 12 12 144 1 PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.549E+0	0
PRINCIPAL HYDROSTATIC PARTICULARS density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): -3.549E+0 VCB (from origin) (m): -3.549E+0	800
density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	
density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	
density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.8 Waterline Length (m) : 4.134E+2 Waterline Beam (m) : 4.586E+1 Maximum Draft (m) : 1.033E+1 Displacement (m^3) : 1.606E+4 Wetted Surface Area (m^2) : 8.291E+3 LCB (from origin) (m) : 8.023E+1 TCB (from origin) (m) : 0.000E+0 VCB (from origin) (m) : -3.549E+0	
Waterline Length (m): 4.134E+2 Waterline Beam (m): 4.586E+1 Maximum Draft (m): 1.033E+1 Displacement (m^3): 1.606E+4 Wetted Surface Area (m^2): 8.291E+3 LCB (from origin) (m): 8.023E+1 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.549E+0	
Waterplane Area (m^2) : 2.896E+3	
Waterplane Area (m^2) : $2.896E+3$ LCF $(from\ origin)$ (m) : $8.556E+1$ Metacentric height (m) : $1.753E+1$	
Metacentric height (m) : 1.753E+1	
Mass (kg) : 1.200E+7	
Mass/density (m^3) : 1.171E+4	
LCG (from origin) (m): 9.929E+1	
VCG (from origin) (m) \cdot -3 947Fin	
Radii of Gyration (m) : 0.000E+0 (ro	11)
(about CG) (m) : 0.000E+0 (pit	tch
Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 9.929E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -3.947E+0 Radii of Gyration (m) : 0.000E+0 (ro (about CG) (m) : 0.000E+0 (pit (m) : 0.000E+0 (yant)	aw)
	٠,
STEADY FORCE AND RESPONSE	
Ship Speed (m/s) : 1.543E+1	
Ship Speed (m/s) : 1.543E+1 Ship Speed (knots) : 2.996E+1	
Ship Speed (knots): 2.996E+1 Wetted Surface Area (m^2): 8.291E+3	. – – -
Ship Speed (knots) : 2.996E+1 Wetted Surface Area (m^2) : 8.291E+3 Rw (kN) : 1.543E+3	
Ship Speed (knots): 2.996E+1 Wetted Surface Area (m^2): 8.291E+3	

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			anth the	DMARITON	
	Name		GRID INFO		
				SSG File	
Sheet#	NP1	NP2	NP	KP	MP
1	6	80	480	3	0
2	19	80	1520	3 2	0
3	55	12	660	2	1
4	14	7	NP 480 1520 660 98	5 5	1
5	14	-7	98	5	1
6	12	12	144	1	0
	PRINCIPA	L HYD	ROSTATIC	PARTICULA	RS
density (kg/	m^3)= 1025	.000	gravity	$(m/s^2) =$	9.800
Wat	erline Len	gth	(m)	: 4.134	E+2
Wat	erline Bear	m	(m)	: 4.586)E+1
Max	nlacement		(m^3)	1.033	E-1
Wet	ted Surfac	e Are	(m^2)	8.291	E+3
LCB	(from ori	gin)	(m)	: 8.023	E+1
TCB	(from ori	gin)	(m)	: 0.000	E+0
VCB	erline Lenerline Bearimum Draft placement ted Surfac (from oriofrom oriofro	gin)	(m)	: -3.549	9E+0
Wat	erplane Ar (from ori acentric h	ea	(m^2)	: 2.896	E+3
LCF	(from ori	gin)	(m)	: 8.556	E+1
Mas	g		(ka)	. 1 200)E+7
Mas	s/densitv		(m^3)	: 1.171	E+4
LCG	(from ori	gin)	(m)	: 9.929	E+1
TCG	(from ori	gin)	(m)	: 0.000	E+0
VCG	s/density (from ori- (from ori- (from ori- of Gyration ut CG)	gin)	(m)	: -3.947	'E+0
Radii d	of Gyration	1	(m) :	0.000E+0	(roll)
(abo	ut CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
				RESPONSE	
Shi	p Speed p Speed ted Surfac		(m/s)	: 1.800)E+1
Sni	p speed	0 7 200	(KHOUS)	: 3.495	D 1 2
Wet	ced suriac	e Are	a (III ∠) (k-NT)	. 8.∠91) 比 T 3 T 正 + つ
T.W C'tat			(1/11/)	. 9 587	льтэ РЕ-4
Sin	kage		(m)	: 8.375	E+0
	m at CG		(dea)	: 8.375 : 4.165	E+0
	uo oo 				

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*		SWAN2	2002	SOLVE		
* *						
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				 GRID INFO	 RMATION	
			:	tsuR076	SSG File	
	Sheet#	NP1	NP2		KP	MP
	1 2	6 19	8 O	480 1520	3 3	0 0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6 	12	12	144	1	0
dens		^3)= 1025	.000	gravity	PARTICULAR (m/s^2) =	S 9.800
	Wate	rline Len	a+h	(m)	. / 13/1	 ∃+2
	Wate	rline Bea	ım	(m)	: 4.5861	∃+1
	Maxi	mum Draft		(m)	: 1.0331	3+1
	Disp	lacement	. 7	(m^3)	: 1.6061	3+4
	wett	ed Suriac (from ori	e Area	1 (m ∠) (m)	: 8.2911 · 9.0181	5+3 7⊥1
	TCB	(from ori	gin)	(m)	: 0.0001	Ξ+0
	VCB	(from ori	gin)	(m)	: 4.5861 : 1.0331 : 1.6061 : 8.2911 : 9.0181 : 0.0001 : -3.5491	Ξ+0
					: 2.8961 : 9.0281 : 1.7531	
	LCF	(from ori	gin)	(m)	: 9.0281	Z+1
	Mass	/ 3		(kg)	: 1.2001 : 1.1711 : 9.9291 : 0.0001 : -3.9471 0.000E+0	Ξ +7
	Mass	/density (from ori	air)	(m 3) (m)	: 1.1711	5+4 7⊥1
	TCG	(from ori	ain)	(iii) (m)	. 9.9291	3+0 3+1
	VCG	(from ori	gin)	(m)	: -3.9471	 ∃+0
	Radii of	Gyration	n	(m) :	0.000E+0	(roll)
	(abou	t CG)		(m) :	0.000E+0	(pitch
				(m) :	0.000E+0	(yaw)
		ST	EADY I	FORCE AND	RESPONSE	
	Ship	Speed		(m/s)	: 7.7201 : 1.4991 : 8.2911	 E+0
	Ship	Speed	-	(knots)	: 1.4991	3+1
	Wett	ed Surtac	e Area	a (m ⁻ 2)	: 8.291	±+3
	Rw Cw			(kN)	: 3.5851 : 1.4161	
	Sink	age		(m)	: 2.7121	Ξ+ 0

******	*****	*****	*****	*****	******
*	SWAN2	2002	SOLVE		*
* *					*
* Mass			(C) 2002 tute of 5	Technology	*
* *******	*****	*****	*****	*****	* *****
	Name		GRID INFO	RMATION SSG File	
Sheet# 1	NP1 6	NP2 80	NP 480 1520	KP 3	MP 0
2	19	80	1520	3 3 2	0
3	55	12	660	2	1
4 5	14 14	7 7	98 98	5 5	1 1
6			144	1	0
density (kg/m	n^3)= 1025	.000	gravity		RS 9.800
Wate	rline Len	at h	(m)	. / 13/	E+2
Wate	erline Bea	m	(m)	: 4.586	E+1
Maxi	mum Draft		(m)	: 1.033	E+1
Disp	lacement	. 7	(m^3)	: 1.606	E+4
Wett	ed Surfac	e Are	a (m 2)	: 8.291 • 9.018	ല+3 ₽⊥1
TCB	(from ori	gin)	(m)	: 0.000	E+0
VCB	(from ori	gin)	(m)	4.586 : 1.033 : 1.606 : 8.291 : 9.018 : 0.000 : -3.549	E+0
Wate	erplane Ar	ea	(m^2)	: 2.896	E+3
LCF	(from ori	gin)	(m)	: 2.896 : 9.028 : 1.753	E+1
Mass	3		(kg)	: 1.200 : 1.171 : 9.929 : 0.000 : -3.947 0.000E+0	E+7
Mass	density		(m^3)	: 1.171	E+4
LCG	(from ori	gin)	(m)	9.929	E+1
VCG	(from ori	gin) ain)	(m)	: -3.947	E+0
Radii o	f Gyration) —, 1	(m) :	0.000E+0	(roll)
(aboı	ıt CG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0	(yaw)
	ST	EADY	FORCE AND	RESPONSE	
Ship	Speed		(m/s)	: 1.028	E+1
Shir	Speed	-	(knots)	: 1.028 : 1.996 : 8.291	E+1
Wett Rw	ed Surfac	e Are		: 8.291 : 4.822	E+3
KW Cw			, ,	: 4.822 : 1.074	
	age		(m)	: 3.109	E+0
Trin	n at CG		(deg)	: 1.034	E+0

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* *	SWAN2	2002	SOLVE		
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	Mama		GRID INFO		
			tsuR076	55G FITE	
Sheet 1	# NP1	NP2	NP 480 1520 660	KP	MP 0
	. 6 19	80	1520	3	0
3	55			3 3 2	1
4		7		5	1
5		7 12	98 144	5 1	1
density (k	PRINCIPA g/m^3) = 1025	L HYI	ROSTATIC gravity	PARTICULAR (m/s^2) =	s 9.800
	aterline Len				
W.	aterline Len aterline Bea	gtn m	(III) (m)	4.134E	5+∠ 7+1
M	aximum Draft	•••	(m)	: 1.033E	3+1
D	isplacement		(m^3)	: 1.606E	E+4
W	etted Surfac	e Are	a (m^2)	: 8.291E	I+3
т. Т-	CB (from ori	gin) gin)	(m) (m)	9.0186	5+1
V	aterline Bea aximum Draft isplacement etted Surfac CB (from ori CB (from ori	gin)	(m)	: -3.549E	E+0
L	CF (from ori	gin)	(m)	: 9.028E	G+1
	aterplane Ar CF (from ori etacentric h				
	ass ass/density CG (from orions CG (GYPATIONS CG)		(kg)	: 1.200E	 G+7
M	ass/density		(m^3)	: 1.171E	E+4
L	CG (from ori	gin)	(m)	: 9.929E	C+1
.T.	CG (from ori	gin) gin)	(m) (m)	: 0.000E	5+0 7±0
Radii	of Gyration	9 ±117 1	(m) :	0.000E+0	(roll)
(a	bout ĈG)		(m) :	0.000E+0	(pitch
			(m) :	0.000E+0	(yaw)
				RESPONSE	
S:	hip Speed hip Speed etted Surfac		(m/s)	: 1.286E	 E+1
S	hip Speed		(knots)	: 2.497E	E+1
W	etted Surfac	e Are	a (m^2) (kN)	: 8.291E	Z+3
R' C'			, ,	: 1.949E : 2.774E	
	" inkage		(m)	: 2.764E	
T	rim at CG		(deg)	: 9.831E	E-1

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				GRID INFO	RMATION	
		Name	:	tsuR076	SSG File	
	Sheet#	NP1	NP2	NP 480 1520 660 98 98	KP	MP
	1 2	0	80	480	3 3 2 5	0
	3	19 55	12	1520	3	0 1
	4	14	7	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1	0
		PRINCIP	AL HY	DROSTATIC	PARTICULA	RS
dens					(m/s^2) =	
	Wate	rline Le	ngth	(m)	: 4.134 : 4.586 : 1.033 : 1.606 : 8.293 : 9.018 : 0.000 : -3.549	1E+2
	Wate	rline Bea	am	(m)	: 4.586	5E+1
	Maxi	mum Draii lacement	Ę.	(m/3)	1.033	2E+1
	Wett	ed Surfac	ce Are	(m^2)	8.291	1E+3
	LCB	(from or:	igin)	(m)	: 9.018	3E+1
	TCB	(from or:	igin)	(m)	: 0.000)E+0
	VCB	(from or:	igin)	(m)	: -3.549	9E+0
	Wate	rplane A	rea	(m^2)	: 2.896 : 9.028 : 1.753	5E+3
	LCF	(from or	igin)	(m)	: 9.028	3E+1
	Meta 	centric 1	neight 	(m)	: 1.753	3E+1
	Mass	/ 3		(kg)	: 1.200 : 1.173 : 9.929 : 0.000 : -3.947 0.000E+0 0.000E+0)E+7
	Mass	/density	: ~ : ~ \	(m ³)	: 1.171	LE+4
	TCG	(from or	igin)	(III) (m)	. 9.923) E + U
	VCG	(from or	igin)	(m)	: -3.947	7E+0
	Radii of	Gyratio	n	(m) :	0.000E+0	(roll
	(abou	t ĈG)		(m) :	0.000E+0	(pitch
				(m) :	0.000E+0) (yaw)
			 TEADY	FORCE AND	RESPONSE	
		Cnood		(m/a)	. 1 545	
	Sillp	Speed		(III/S)	. 1.543	5E+1
	Wet.t.	ed Surfac	ce Are	a (m^2)	: 8.291	LE+3
	Rw			(kN)	: 1.543 : 2.996 : 8.291 : 4.033 : 3.985	3E+2
	Cw			• •		
	Sink				: -1.253	3E+0
	Trim	at CG		(deg)	: -9.176	5E-1

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r									*
ŧ	SV	IAN2	2002	SOL	VE				*
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	3.7				INFC				
	Nar		:						
Sne	eet# NP1	_	NP2		NP 480		KP	MP	
	1 6)	80	1			3 3 2 5	0	
	2 19	-	80	Т	520		3	0	
	3 55 4 14		12		660		2	1	
	4 14	Ŀ	-7		98		5	1	
	5 14		NP2 80 80 12 7 7		98 98 144		5	1	
	6 12	2	12		144		1	0	
	יייייייייייייייייייייייייייייייייייייי	ICT D7	T UVI	DDOGT	יאיידרי	ים גם	ricula	DC	
donaitu									0
density	(kg/m^3)=	1023	.000	gra	νтсу	(111/5	۷) =	J.60	U
	Waterline Waterline Maximum D Displacem Wetted Su LCB (from TCB (from	Lon	ath		(m)		/ 13/	 1 配より	
	Waterline	Bear	y cii		(III) (m)	:	1 50	±15+2 517±1	
	Marimum D	raft	111		(III) (m)		1 03	2 E + 1	
	Dianlacom	ont		(m)	(III) ^>\	:	1 60	2 E 1 V	
	Dispiacem	∞foa	0 7 700) (III	3) ^2\	•	1.000	10.2	
	TCD /from	rrac	e Ale	a (III	2) (m)	:	0.29.	15-1	
	TCD (from	011	9111)		(III) (m)	:	9.01) E · V	
	TCD (from	011	9111)		(III) (m)	•	2 54	75.0	
	VCB (from	OLI	giii)		(111)	:	-3.54	7E+U	
	Waternlan	e Ar	e a	(m ′	^21				
	ICE (from	Ori	ca cinl	(111	(m)		2.896 9.028) II . 1	
	Waterplan LCF (from Metacentr	iah	giii)		(III) (m)	:	1.75		
	Metacenti	10 11	ergiic		(111)	· 			
·	Mass Mass/dens LCG (from TCG (from VCG (from dii of Gyra (about CG)			/1	دم) 		1 20	 1F±7	
	Mass/dens	i + 17		(m)	3)	:	1 17	1E+4	
	I.CG (from	-cy	ain)	(111	(m)	:	9 92	± 3₽-1	
	TCG (from	Ori	gin)		(III)	:	0.94	ノロ・レ	
	VCG (from	Ori	giil)		(III) (m)		-3 04	7₽±0	
Pag	veg (IIOIII	tior	л Атп <i>)</i>	(m)	•	. 0 (- <i>3.9</i> 4 1000±0	(roll	1)
Rat	(apont GG)	i C I OI	1	(III)		0.0	UUE · ∪	(ni+a	⊥/ h۱
	(about CG)			(m) (m)	: .	0.0	0005.4	(http://	11)
				(111)		· ·) (yaw	1
		СШ	EVDV	בטסטי	יואע ד	י סבים	PONSE		
								 1⊡⊥1	
	Ship Spee Ship Spee Wetted Su	u d		(III)	/ is /		T.000	ノロ+1 Tロ・1	
	purh shee	u wfar	0 7	(KIIO)	~ a \	:	0.49)ロ・2 	
	wettea Su	riac	e are						
	Rw			()	ζN)	:	5.47	ヺ ビ +Ζ	
	Cw				, ,	:	3.980	JE-4	
	Sinkage	_		, -	(m)	:	3.980 -2.658 -1.580	3E+0	
	Trim at C	G		(de	eg)	:	-1.580)E+0	

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	37		GRID INFO		
	Name		tsuR077	SSG File	
Sheet#		NP2		KP	MP
1	6	80	480	3	0
2	19	80		3	Ö
3	55	12		2	í
4	14	7	98	2 5	1
5	14	7	98	5	1
6	12	12	144	1	0
3				PARTICULA	
density (kg/m			gravity	(m/s 2) =	9.800
.т.	rline Len	at h	(m)	: 4.134	1 〒 1 つ
Wate Wate	rline Bea	y cii	(III)	. 4.13	±6+2 5₽±1
Mari	mum Draft		(m)	1.033	3E+1
Disp	lacement		(m^3)	1.606	5E+4
Wett	ed Surfac	e Area	a (m^2)	: 8.293	LE+3
LCB	(from ori	ain)	(m)	: 1.113	3E+2
TCB	(from ori	gin)	(m)	: 0.000)E+0
VCB	(from ori	gin)	(m)	: 4.586 : 1.033 : 1.606 : 8.293 : 1.113 : 0.000 : -3.549	9E+0
Wate	rplane Ar (from ori centric h	ea	(m^2)	: 2.896 : 1.003	5E+3
LCF	(from ori	gin)	(m)	: 1.003	
Meta	centric h	eight	(m)	: 1.753	
Magg			(150)	: 1.200 : 1.173 : 1.113 : 0.000 : -3.94 0.000E+0 0.000E+0	
Mass	/dengity		(m^3)	. 1.200	7E+7
I.CG	(from ori	ain)	(m)	. 1.17	RE+2
TCG	(from ori	gin)	(m)	: 0.000)E+0
VCG	(from ori	gin)	(m)	: -3.94	7E+0
Radii ot	f Gyration	i .	(m) :	0.000E+0	(roll)
(abou	t ĈG)		(m) :	0.000E+0	(pitch)
			(m) :	0.000E+0) (yaw)
		ו ערוגם		DECDOMCE	
	51	EADI I	ANL	RESPONSE	
Shin	Speed		(m/s)	: 7.720	DE+0
Ship	Speed Speed		(knots)		
Wett	ed Surfac	e Area	a (m^2)		LE+3
Rw			(kN)	. 8 091	5E+1
Cw				: 3.19	7E-4
Sink	age		(m)	: 5.474	4E-1
Trim	at CG		(dèg)	: 3.19° : 5.474 : -4.869	9E-1

		SWAN2	2002	SOLVE		
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				GRID INFO	 RMATTON	
		Name	:	tsuR077	SSG File	
	Sheet# 1	NPI	NP2	NP 480 1520 660	KP	MP 0
	2	19	80	1520	3 3 2	0
	3	55	12	660	2	1
	4	14	7	98	5	1
	5	14	7 7	98 98	5	1
	6	12		144	1	0
		PRINCIP	AL HYD	ROSTATIC	PARTICULA	 RS
densit	y (kg/m	^3) = 1025	5.000	gravity	PARTICULA (m/s^2) =	9.80
	Wate	rline Ler	ngth	(m)	: 4.134	E+2
	Wate	rline Bea	am	(m)	: 4.586	E+1
	Maxi	mum Drait		(m) (m^2)	1.033	3E+1
	Disp	lacement	~ ~ 7	(m 3)	: 1.606	DE+4
	well	ed Suriac	se Area	d (III ∠) (m)	. 8.291	LE+3
	TCB	(from or	igin)	(III) (m)	. 0.000)E+7
	VCB	(from or	iain)	(m)	: 4.134 : 4.586 : 1.033 : 1.606 : 8.293 : 1.113 : 0.000 : -3.549	9E+0
	Wate	rplane A	rea	(m^2)	: 2.896	E+3
	LCF	(from or:	igin)	(m)	: 1.003	8E+2
	Meta	centric h	neight	(m)	: 2.896 : 1.003 : 1.753	8E+1
	Magg			(ka)	. 1 200) 7
	Mass	/density		(m^3)	: 1.200 : 1.173 : 1.113 : 0.000 : -3.945 0.000E+0	E+4
	LCG	(from or	igin)	(m)	: 1.113	BE+2
	TCG	(from or	igin)	(m)	: 0.000)E+0
	VCG	(from or	igin)	(m)	: -3.947	7E+0
	Radii of	Gyratio	n	(m) :	0.000E+0	(rol
	(abou	t ĈG)		(m) :	0.000E+0	(pite
				(m) :	0.000E+0 0.000E+0	(yaı
					RESPONSE	
	Shin	Speed		(m/s)	: 1.028 : 1.996 : 8.293 : 4.309 : 9.596 : 1.168	 3E+1
	Ship	Speed		(knots)	: 1.996	E+1
	Wett	ed Surfac	ce Area	a (m^2)	: 8.291	LE+3
	Rw			(kN)	: 4.309	9E+2
	Cw			(m) (deg)	: 9.596	E-4
	Sink	age		(m)	: 1.168 : -1.503	3E+0

		SWAN2	2002	SOLVE		
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		Q		(a) 0000		
	Magg			(C) 2002	Technology	
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*****	******	*****	*****	*****	*****	*****
				GRID INFO	ORMATION	
		Name			SSG File	
	Sheet#				KP	
	1	6	80	480	3	0
	2	NP1 6 19 55	80	1520	3	0
	3	55	12	660 98 98	2	1
	4	14	./	98	5	1
	5	14	7	98	5	1
	6	12	12	144	1,	0
					· ·	
don	aita (lea/m	PRINCIPA	AL HYD	ROSTATIC	PARTICULAI (m/s^2) =	RS a on
	(kg/iii	. 3/= 1023		gravity	(111/5 2)=	
	Wate	rline Len	igth	(m)	: 4.134	E+2
	Wate	rline Bea	ım	(m)	: 4.586	E+1
	Maxi	mum Draft	:	(m)	: 1.033	E+1
	Disp	lacement		(m^3)	: 1.606	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.291	E+3
	LCB	(from ori	.gin)	(m)	: 1.113	E+2
	TCB	(from ori	.gin)	(III) (m)	: 4.584 : 1.033 : 1.606 : 8.291 : 1.113 : 0.000	1E+0
	VCБ		.9111 <i>)</i> 	(111)		
	Wate	rplane Ar	rea	(m^2)	: 2.896 : 1.003 : 1.753	E+3
	LCF	(from ori	.gin)	(m)	: 1.003	E+2
	Meta	centric h	neight	(m)	: 1.753	E+1
	Mass			(ka)	: 1.200 : 1.171 : 1.113 : 0.000 : -3.947 0.000E+0 0.000E+0	 E+7
	Mass	/densitv		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 1.113	E+2
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	E+0
	Radii of	E Gyration	n	(m) :	0.000E+0	(rol]
	(abou	t CG)		(m) :	0.000E+0	(pitc
				(m) :	0.000E+0	(yaw
		ST	EADY	FORCE ANI	D RESPONSE	
	Shin	Speed		(m/s)	. 1 296	 E+1
	Shin	Speed		(knots)	. 2.497	E+1
	Wett	ed Surfac	e Are	a (m^2)	: 8.291	E+3
	Rw			(kN)	: 1.286 : 2.497 : 8.291 : 5.259	E+2
	Cw				: 5.259 : 7.484	E-4
		age		(m)	: 3.418	17 1
				(111)	. 3.410	- T

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		Name		GRID INFO	ORMATION SSG File	
	Sheet#	NP1	NP2	NP 222 407 312	KP	MP
	1 2	6	3.7	222	3	0
	3	11 26	37 37 12	4U/ 310	3 3 2	0 1
	4	26 7	7	49	5	1
	5	7	7	49	5	1
	6		12	144		0
		PRINCIP	AL HYI	ROSTATIO	PARTICULA	RS
den	sity (kg/m	^3) = 1025	.000	gravity	$(m/s^2) =$	9.80
	Mata	rline Ler	a+h	(m)	. / 12/	 E+2
	Wate	rline Bea	ım	(m)	: 4.585	E+1
	Maxi	mum Draft		(m)	: 1.033	BE+1
	Disp	lacement		(m^3)	: 1.547	E+4
	Wett	ed Surfac	e Are	a (m^2)	: 8.184	E+3
	LCB	(from ori	gin)	(m)	: 1.117	E+2
	TCB	(from ori	.gin)	(m)	: 0.000)E+0
	VCB	(Irom ori	.g1n) 	(m)	: 4.585 : 1.033 : 1.547 : 8.184 : 1.117 : 0.000	5E+U
	Wate	rplane Ar	ea	(m^2)	: 2.805	E+3
	LCF	(from ori	gin)	(m)	: 1.011	E+2
	Meta	centric h	eight	(m)	: 2.805 : 1.011 : 1.577	'E+1
	Mass			(ka)	: 1.200 : 1.171 : 1.113 : 0.000 : -3.947 0.000E+0)E+7
	Mass	/density		(m^3)	: 1.171	E+4
	LCG	(from ori	gin)	(m)	: 1.113	8E+2
	TCG	(from ori	gin)	(m)	: 0.000	E+0
	VCG	(from ori	gin)	(m)	: -3.947	'E+0
	Radii oi	Gyratio:	n	(m) :	0.000E+0	(roll
	(abou	t CG)		(m) :	0.000E+0 0.000E+0	(pitc.
				(111) :	0.000E+C	(yaw
		ST	'EADY	FORCE ANI	RESPONSE	
		Cnood		(m/a)	. 1 543	
	Snip	Speed		(m/s)	: 1.543	[문고1
	Me++ Siitb	speeu ed Surfac	e Are	(W ₂)	. 2.996	E+3
	Rw	Ja Darrac	1110	(kN)	: 1.543 : 2.996 : 8.184 : 2.709	E+2
	Cw				: 2.709 : 2.713	E-4
	Sink	age		(m)	: 5.020	
				(deg)	: 1.93	

APPENDIX A: Section 18: Condition 1-6 SWAN2 Output

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SWAN2 2002 SOLVE
                                                                          Copyright (C) 2002
                                            Massachusetts Institute of Technology
                                                                                              GRID INFORMATION : tsuR077 SSG File
                                                                   Name

        Sheet#
        NP1
        NP2
        NP
        KP
        MP

        1
        6
        80
        480
        3
        0

        2
        19
        80
        1520
        3
        0

        3
        55
        12
        660
        2
        1

        4
        14
        7
        98
        5
        1

        5
        14
        7
        98
        5
        1

        6
        12
        12
        144
        1
        0

                                                                PRINCIPAL HYDROSTATIC PARTICULARS
               density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800
density (kg/m^3) = 1025.000 gravity (m/s^2) = 9.800

Waterline Length (m): 4.134E+2
Waterline Beam (m): 4.586E+1
Maximum Draft (m): 1.033E+1
Displacement (m^3): 1.606E+4
Wetted Surface Area (m^2): 8.291E+3
LCB (from origin) (m): 1.113E+2
TCB (from origin) (m): 0.000E+0
VCB (from origin) (m): -3.549E+0

Waterplane Area (m^2): 2.896E+3
LCF (from origin) (m): 1.003E+2
Metacentric height (m): 1.753E+1

Mass (kg): 1.200E+7
                                 Mass (kg) : 1.200E+7
Mass/density (m^3) : 1.171E+4
LCG (from origin) (m) : 1.113E+2
TCG (from origin) (m) : 0.000E+0
VCG (from origin) (m) : -3.947E+0
Radii of Gyration (m) : 0.000E+0 (roll)
(about CG) (m) : 0.000E+0 (pitch)
(m) : 0.000E+0 (yaw)
                                                                       STEADY FORCE AND RESPONSE
  Ship Speed (m/s): 1.800E+1
Ship Speed (knots): 3.495E+1
Wetted Surface Area (m^2): 8.291E+3
Rw (kN): 3.122E+3
Cw : 2.268E-3
Sinkage (m): 3.889E+0
Trim at CG (deg): 1.632E+0
```

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APPENDIX B: CENTER HULL SWAN2 OUTPUT

SWAN2 2002 SOLVE Copyright (C) 2002 Massachusetts Institute of Technology GRID INFORMATION Name : mon15 SSG File Sheet# NP1 NP2 NP 1 17 30 510 2 24 8 192 3 8 8 64 NP KP MP 3 30 3 2 1 192 64 3 8 PRINCIPAL HYDROSTATIC PARTICULARS density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$ Waterline Length (m): 4.206E+2 Waterline Beam (m): 2.002E+1 Maximum Draft (m): 7.910E+0 Displacement (m^3): 1.645E+4 Wetted Surface Area (m^2): 5.157E+3 LCB (from origin) (m): 1.128E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.260E+0 Waterplane Area (m^2): 2.886E+3 LCF (from origin) (m): 1.009E+2 Metacentric height (m): 6.680E+0 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 6.764E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -5.326E+0 Radii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) STEADY FORCE AND RESPONSE 7.720E+0 1.499E+1 5.157E+3 6.180E+1 3.924F Ship Speed (m/s) : Ship Speed (knots) : Wetted Surface Area (m^2) : (m/s) :

(kN) :

3.924E-4

(m) : -7.396E+0 (deg) : -5.088E+0

Rw C_{M}

Sinkage Trim at CG

SWAN2 2002 SOLVE Copyright (C) 2002 Massachusetts Institute of Technology GRID INFORMATION : mon20 SSG File Name ______ Sheet# NP1 NP2 NP 1 17 30 510 2 24 8 192 3 8 8 64 192 64 PRINCIPAL HYDROSTATIC PARTICULARS density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$ Waterline Length (m): 4.206E+2 Waterline Beam (m): 2.002E+1 Maximum Draft (m): 7.910E+0 Displacement (m^3): 1.645E+4 Wetted Surface Area (m^2): 5.157E+3 LCB (from origin) (m): 1.128E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.260E+0 -----Waterplane Area (m^2): 2.886E+3 LCF (from origin) (m): 1.009E+2 Metacentric height (m): 6.680E+0 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 6.764E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -5.326E+0 Lii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) Radii of Gyration (about CG) STEADY FORCE AND RESPONSE Ship Speed (m/s): Ship Speed (knots): Wetted Surface Area (m^2): 1.028E+1 ed (knots): 1.996E+1 urface Area (m^2): 5.157E+3 (kN): 4.543E+1 : 1.627E-4 Rw (..., Cw : 1.627E-4 Sinkage (m) : -7.416E+0 Trim at CG (deg) : -5.060E+0 Rw

SWAN2 2002 SOLVE Copyright (C) 2002 Massachusetts Institute of Technology GRID INFORMATION : mon25 SSG File Name ______ Sheet# NP1 NP2 NP 1 17 30 510 2 24 8 192 3 8 8 64 MP 192 64 PRINCIPAL HYDROSTATIC PARTICULARS density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$ Waterline Length (m): 4.206E+2 Waterline Beam (m): 2.002E+1 Maximum Draft (m): 7.910E+0 Displacement (m^3): 1.645E+4 Wetted Surface Area (m^2): 5.157E+3 LCB (from origin) (m): 1.128E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.260E+0 _____ Waterplane Area (m^2): 2.886E+3 LCF (from origin) (m): 1.009E+2 Metacentric height (m): 6.680E+0 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 6.764E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -5.326E+0 Lii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) Radii of Gyration (about CG) STEADY FORCE AND RESPONSE Ship Speed (m/s): Ship Speed (knots): Wetted Surface Area (m^2): 1.286E+1 ed (knots) : 2.497E+1 urface Area (m^2) : 5.157E+3 (kN) : 9.320E+1 : 2.133E-4 Rw (..., Cw : 2.133E-4 Sinkage (m) : -7.497E+0 Trim at CG (deg) : -5.043E+0 Rw

SWAN2 2002 SOLVE Copyright (C) 2002 Massachusetts Institute of Technology GRID INFORMATION : mon30 SSG File Name ______ Sheet# NP1 NP2 NP 1 17 30 510 2 24 8 192 3 8 8 64 192 64 PRINCIPAL HYDROSTATIC PARTICULARS density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$ Waterline Length (m): 4.206E+2 Waterline Beam (m): 2.002E+1 Maximum Draft (m): 7.910E+0 Displacement (m^3): 1.645E+4 Wetted Surface Area (m^2): 5.157E+3 LCB (from origin) (m): 1.128E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.260E+0 _____ Waterplane Area (m^2): 2.886E+3 LCF (from origin) (m): 1.009E+2 Metacentric height (m): 6.680E+0 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 6.764E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -5.326E+0 Lii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) Radii of Gyration (about CG) STEADY FORCE AND RESPONSE Ship Speed (m/s): Ship Speed (knots): Wetted Surface Area (m^2): ed (Mnots): 2.996E+1 urface Area (m^2): 5.157E+3 (kN): 4.456E+2 : 7.083E-4 1.543E+1 Rw (..., Cw : 7.083E-4 Sinkage (m) : -7.765E+0 Trim at CG (deg) : -5.094E+0 Rw

SWAN2 2002 SOLVE Copyright (C) 2002 Massachusetts Institute of Technology GRID INFORMATION : mon35 SSG File Name ______ Sheet# NP1 NP2 NP 1 17 30 510 2 24 8 192 3 8 8 64 192 64 PRINCIPAL HYDROSTATIC PARTICULARS density $(kg/m^3) = 1025.000$ gravity $(m/s^2) = 9.800$ Waterline Length (m): 4.206E+2 Waterline Beam (m): 2.002E+1 Maximum Draft (m): 7.910E+0 Displacement (m^3): 1.645E+4 Wetted Surface Area (m^2): 5.157E+3 LCB (from origin) (m): 1.128E+2 TCB (from origin) (m): 0.000E+0 VCB (from origin) (m): -3.260E+0 _____ Waterplane Area (m^2): 2.886E+3 LCF (from origin) (m): 1.009E+2 Metacentric height (m): 6.680E+0 Mass (kg) : 1.200E+7 Mass/density (m^3) : 1.171E+4 LCG (from origin) (m) : 6.764E+1 TCG (from origin) (m) : 0.000E+0 VCG (from origin) (m) : -5.326E+0 Lii of Gyration (m) : 0.000E+0 (roll) (about CG) (m) : 0.000E+0 (pitch) (m) : 0.000E+0 (yaw) Radii of Gyration (about CG) STEADY FORCE AND RESPONSE Ship Speed (m/s): Ship Speed (knots): Wetted Surface Area (m^2): 1.800E+1 3.495E+1 5.157E+3 1.432E+3 1.672E-3 3.495E+1 (kN) : Rw (..., Cw : 1.672E-3 Sinkage (m) : -8.582E+0 Trim at CG (deg) : -5.377E+0 Rw

APPENDIX C: SWAN2 TRIMARAN '.PLN' FILE

			183.1900	1.96588300	-6.00001500	138.1900	4.56024800	-6.50001000
			183.1900	2.14754700	-5.49999400	138.1900	5.00005600	-6.35312300
			183.1900	2.22082000	-5.00000500	138.1900	5.53396800	-5.99991400
			183.1900	2.29044200	-4.49999800	138.1900	5.95575600	-5.50004800
			183.1900	2.36169100	-4.00000100	138.1900	6.25025600	-4.99973800
			183.1900	2.43461500	-3.50000100	138.1900	6.47098000	-4.49958100
			183.1900	2.50929100	-3.00001400	138.1900	6.64342800	-3.99955900
			183.1900	2.58516200	-2.49985700	138.1900	6.78114800	-3.49970400
			183.1900	2.65639700	-1.99994100	138.1900	6.89231200	-2.99985200
			183.1900	2.71633200	-1.50004900	138.1900	6.98224100	-2.49998000
				2.76678500			7.05464700	-2.00006700
			183.1900		-1.00004600	138.1900		-1 50007400
			183.1900	2.80947300	-0.50005400	138.1900	7.11224300	
TestCenter			183.1900	2.84547700	-0.00004300	138.1900	7.15708300	-1.00002000
1			183.1900	2.87586600	0.49998500	138.1900	7.19077100	-0.50004100
16			183.1900	2.90170600	4.00000000	138.1900	7.21463300	-0.00002100
16			17			138.1900	7.22979800	0.49999600
209.1100	0.00000000	-6.50000000	168.1900	0.00000000	-6.88607600	138.1900	7.23733400	4.00000000
210.1100	0.00000000	-6.00000000	168.1900	2.60883400	-6.50027600	18		
210.4000	0.00000000	-5.50000000	168.1900	3.26366900	-6.00063600	123.1900	0.00000000	-6.79839000
210.4500	0.00000000	-5.00000000	168.1900	3.45013800	-5.50044400	123.1900	4.99996400	-6.61815200
210.8800	0.00000000	-4.50000000	168.1900	3.54657300	-4.99998400	123.1900	5.68043300	-6.50018000
211.0900	0.00000000	-4.00000000	168.1900	3.64531400	-4.49995300	123.1900	6.87229400	-6.00119600
211.0900	0.00000000		168.1900	3.74442600	-4.00013700	123.1900	7.39552800	-5.49992100
		-3.50000000	168.1900	3.84396500	-3.50003800	123.1900	7.72563600	-5.00055900
211.5100	0.00000000	-3.00000000	168.1900	3.94352800	-2.99993400	123.1900	7.94890300	-4.49977700
211.7100	0.00000000	-2.50000000	168.1900	4.03738400	-2.49971800	123.1900	8.10484800	-3.99966500
211.9200	0.00000000	-2.00000000	168.1900	4.11638200	-2.00000000	123.1900	8.22474700	-3.49997000
212.1300	0.00000000	-1.50000000	168.1900	4.17942800	-1.50005600	123.1900	8.32312900	-2.99997300
212.3400	0.00000000	-1.00000000	168.1900	4.23045000	-1.00010400	123.1900	8.40394700	-2.50008700
212.5500	0.00000000	-0.50000000	168.1900	4.27088900	-0.50009300	123.1900	8.46975700	-2.00000400
212.7600	0.00000000	0.00000000	168.1900	4.30218100	-0.00005800	123.1900	8.52216700	-1.50010000
212.9700	0.00000000	0.50000000	168.1900	4.32577000	0.49998600	123.1900	8.56265300	-1.00007100
213.1900	0.00000000	4.00000000	168.1900	4.34309200	4.00000000	123.1900	8.59248000	-0.50002500
17			18			123.1900	8.61279400	-0.00000900
198.1900	0.00000000	-6.73876500	153.1900	0.00000000	-6.87594800	123.1900	8.62465000	0.50000200
198.1900	0.55957200	-6.50067500	153.1900	3.66318500	-6.50012300	123.1900	8.62902900	4.00000000
198.1900	0.84859800	-6.00036100	153.1900	4.48275800	-6.00065600	17		
198.1900	0.97234200	-5.50000900	153.1900	4.70270800	-5.50022200	108.1900	0.00000000	-6.87346800
198.1900	1.02891000	-5.00002900	153.1900	4.87439700	-5.00008500	108.1900	4.34199100	-6.50010200
198.1900	1.05844200	-4.50000900	153.1900	5.00024600	-4.59190700	108.1900	7.12485500	-6.00054300
198.1900	1.08843700	-4.00002900	153.1900	5.02723800	-4.49999700	108.1900	7.80948600	-5.49969700
198.1900	1.12003800	-3.50000300	153.1900	5.16644400	-4.00010800	108.1900	8.19373000	-5.00007200
198.1900	1.15363000	-2.99998800	153.1900	5.29401600	-3.50016700	108.1900	8.44103500	-4.50049600
198.1900	1.18971300	-2.50001100	153.1900	5.40875800	-2.99969500	108.1900	8.60540400	-3.99973800
198.1900	1.22800000	-1.99995900	153.1900		-2.49976300	108.1900		-3.49989900
198.1900	1.26811300	-1.49974000	153.1900	5.50536000			8.72923300	
198.1900	1.30962500	-0.99984400		5.58376200	-2.00002600	108.1900	8.83092300	-2.99981100
198.1900	1.35218200	-0.49986200	153.1900	5.64585400	-1.50006400	108.1900	8.91469500	-2.50001900
198.1900	1.39538900	0.00015100	153.1900	5.69497700	-1.00010300	108.1900	8.98292600	-2.00008600
198.1900	1.43884400	0.50001700	153.1900	5.73258500	-0.50008400	108.1900	9.03730500	-1.50016700
198.1900	1.48216800	4.00000000	153.1900	5.76011500	-0.00002800	108.1900	9.07903800	-1.00013500
17			153.1900	5.77901600	0.49999400	108.1900	9.10933300	-0.50008500
183.1900	0.00000000	-6.85817600	153.1900	5.79073800	4.00000000	108.1900	9.12942600	-0.00004100
183.1900	1.49775100	-6.50000200	18			108.1900	9.14056500	0.50000000
			138.1900	0.00000000	-6.84264600	108.1900	9.14400000	4.00000000

1	16					
	93.1900	0.00000000	-6.29927800	63.1900	8.97222100	-0.99995500
	93.1900	3.35525900	-6.00088600	63.1900	9.05466100	-0.50002300
	93.1900	6.97448600	-5.49996700	63.1900	9.10698400	-0.00005400
	93.1900	7.78736200	-5.00060800	63.1900	9.13530700	0.49995700
	93.1900	8.21118400	-4.50102200	63.1900	9.14400000	4.00000000
	93.1900	8.47023600	-4.00010300	8		
	93.1900	8.63869300	-3.50008600	48.1900	0.00000000	-2.12761600
	93.1900	8.76670400	-3.00005100	48.1900	6.09337500	-2.00000200
	93.1900	8.86971100	-2.50003700	48.1900	8.14184500	-1.50161000
	93.1900	8.95225000	-2.00008400	48.1900	8.67794400	-0.99976100
	93.1900	9.01718100	-1.50011700	48.1900	8.92446400	-0.49993800
	93.1900	9.06666700	-1.00009800	48.1900	9.05971000	-0.00030900
	93.1900	9.10255200	-0.50006500	48.1900	9.12553500	0.49979600
	93.1900	9.12645500	-0.00001000	48.1900	9.14400000	4.00000000
	93.1900	9.13982600	0.49999600	5		
	93.1900	9.14400000	4.00000000	33.1900	0.00000000	-0.42559100
1	14			33.1900	5.00000000	-0.40526100
	78.1900	0.00000000	-5.16098300	33.1900	8.52721900	-0.00039200
	78.1900	4.02067100	-5.00021000	33.1900	9.03860500	0.50022700
	78.1900	7.32379400	-4.50157300	33.1900	9.14399900	4.00000000
	78.1900	8.02487300	-4.00112700	3		
	78.1900	8.39681700	-3.49967200	23.7800	0.00000000	-0.0100000
	78.1900	8.61576800	-2.99983200	23.7800	0.90000000	0.68455600
	78.1900	8.76810200	-2.49999500	23.7800	9.14400000	1.00000000
	78.1900	8.88518600	-2.00002600	3		
	78.1900	8.97501800	-1.50021600	22.0000	0.00000000	-0.0100000
	78.1900	9.04218900	-1.00013500	22.0000	0.10000000	0.68455600
	78.1900	9.09004500	-0.50009500	22.0000	0.20000000	4.00000000
	78.1900	9.12140800	-0.00003200	9		
	78.1900	9.13867900	0.49999900	-200.5904	0.00000	-0.0100
	78.1900	9.14400000	4.00000000	-200.5904	0.014861	0.30476
1	11			-200.5904	0.028532	0.60957
	63.1900	0.00000000	-3.72232100	-200.5904	0.040678	0.91459
	63.1900	6.21211000	-3.49976500	-200.5904	0.051486	1.21912
	63.1900	7.82984600	-3.00080300	-200.5904	0.063286	1.52400
	63.1900	8.39313500	-2.49920100	-200.5904	0.077378	1.82878
	63.1900	8.67347100	-2.00002800	-200.5904	0.102341	2.43836
	63.1900	8.85026700	-1.50024300	-200.5904	0.123782	4.04800

APPENDIX D: RESISTANCE CALCULATION TABLE

APPENDIX D: RESISTANCE CALCULATION TABLE

Wetted Area knots	ft/sec	Cf-center	Wc/Wall		Cf-side x 2	Ws/Wall	Cp-pod x 2		Ca	Ct		Total Resist		ЕНР	SHP/TON	
Condition 3-1 92470.43	15	25.3		0.478435788				0.001574244		0.0004	0.007006242		415197.75	0.18	19111.930	1.493
	20 25	33.8 42.2		0.478435788 0.478435788				0.001574244 0.001574244		0.0004 0.0004	0.007048468		742550.97	0.24	45573.728 95603.989	3.561 7.471
	30	50.6		0.478435788				0.001574244		0.0004	0.007573696 0.00713176	1680285.37	1246171.21 1690363.58	0.30 0.36	155617.945	12.160
	35	59.1		0.478435788				0.001574244		0.0004	0.00713170		2668068.60	0.30	286565.121	22.393
Condition 3-2 92470.43	15	25.3	0.001/00120	0.478435788	0.002629	0.003263452	0.527/05069	0.001574244	0.00136	0.0004	0.008001642	471308 75	473828.30	0.18	21810.747	1.704
Condition 3-2 /24/0.43	20	33.8		0.478435788				0.001574244		0.0004	0.008572468		902134.76	0.13	55368.111	4.327
	25	42.2		0.478435788				0.001574244		0.0004	0.007391696		1216393.23	0.30	93319.477	7.292
	30	50.6		0.478435788				0.001574244		0.0004	0.00790726	1862997.83	1873076.04	0.36	172438.786	13.475
	35	59.1		0.478435788				0.001574244		0.0004	0.008861104		2855349.19	0.41	306680.078	23.964
Condition 3-3 92470.43	15	25.3	0.001499129	0.478435788	0.002629	0.003263452	0.527405069	0.001574244	0.0006796	0.0004	0.007321242	431232.17	433751.72	0.18	19965.986	1.560
	20	33.8	0.001448028	0.478435788	0.002711	0.003146416	0.527405069	0.001574244	0.0004243	0.0004	0.007061768	739464.45	743943.66	0.24	45659.204	3.568
	25	42.2		0.478435788				0.001574244		0.0004	0.006892296		1134683.76	0.30	87050.875	6.802
	30	50.6		0.478435788				0.001574244		0.0004	0.00721046	1698827.56	1708905.78	0.36	157324.973	12.294
	35	59.1	0.001355158	0.478435788	0.003219	0.002936081	0.527405069	0.001574244	0.000374	0.0004	0.007364104	2361564.77	2375282.33	0.41	255118.279	19.935
Condition 3-4 92470.43	15	25.3		0.478435788				0.001574244		0.0004	0.006999542		414803.11	0.18	19093.764	1.492
	20 25	33.8 42.2		0.478435788 0.478435788				0.001574244 0.001574244		0.0004 0.0004	0.007032368 0.006953596		740865.07 1144713.37	0.24 0.30	45470.257 87820.329	3.553 6.862
	30	50.6		0.478435788				0.001374244		0.0004	0.000933396		1702850.70	0.36	156767.532	12.250
	35	59.1		0.478435788				0.001574244		0.0004	0.007732004		2493262.69	0.41	267790.013	20.926
Condition 3-5 92470.43	15	25.3		0.478435788				0.001574244		0.0004	0.008281642		490320.72	0.18	22569.909	1.764
	20	33.8		0.478435788				0.001574244		0.0004	0.008405468		884647.56	0.24	54294.842	4.243
	25	42.2		0.478435788				0.001574244		0.0004	0.006935996		1141833.75	0.30	87599.409	6.845
	30 35	50.6		0.478435788				0.001574244		0.0004		1922606.14	1932684.36	0.36	177926.436	13.903
		59.1	0.001333138	0.478435788	0.003219	0.002936081	0.52/405069	0.001574244	0.002268	0.0004	0.009258104	2908943.93	2982661.52	0.41	320354.116	25.033
Condition 3-6 92470.43	15	25.3		0.478435788				0.001574244		0.0004	0.007699642		456040.05	0.18	20991.938	1.640
	20	33.8		0.478435788				0.001574244		0.0004	0.007177268		756038.10	0.24	46401.495	3.626
	25	42.2		0.478435788				0.001574244		0.0004	0.007342796		1208392.44	0.30	92705.671	7.244
	30	50.6		0.478435788				0.001574244		0.0004	0.00752816		1783757.80	0.36	164215.987	12.832
	35	59.1	0.001355158	0.478435788	0.003219	0.002936081	0.527405069	0.001574244	0.0008135	0.0004	0.007803604	2502506.24	2516223.81	0.41	270256.162	21.118
Condition 2-1 88228.47	15	25.3	0.001499129	0.501438661	0.002629	0.003263452	0.518635017	0.001574244	0.0002156	0.0004	0.006863106	404247.25	406766.80	0.18	18723.846	1.499
	20	33.8	0.001448028	0.501438661	0.002711	0.003146416	0.518635017	0.001574244	0.00003417	0.0004	0.006677353	699210.86	703690.07	0.24	43188.658	3.457
	25	42.2		0.501438661		0.003059917	0.518635017	0.001574244	0.0004892	0.0004	0.006881497		1132916.78	0.30	86915.316	6.957
	30	50.6		0.501438661				0.001574244		0.0004	0.007202858		1707114.69	0.36	157160.082	12.579
	35	59.1	0.001355158	0.501438661	0.003219	0.002936081	0.518635017	0.001574244	0.0006421	0.0004	0.007637627	2449279.73	2462997.30	0.41	264539.345	21.173
Condition 2-2 88228.47	15	25.3	0.001499129	0.501438661	0.002629	0.003263452	0.518635017	0.001574244	0.0002075	0.0004	0.006855006	403770.15	406289.70	0.18	18701.884	1.497
	20	33.8	0.001448028	0.501438661	0.002711	0.003146416	0.518635017	0.001574244	0.0001575	0.0004	0.006800683	712125.21	716604.42	0.24	43981.270	3.520
	25	42.2	0.001410087	0.501438661	0.002524	0.003059917	0.518635017	0.001574244	0.0003824	0.0004	0.006774697		1115442.67	0.30	85574.734	6.849
	30	50.6	0.001379686	0.501438661	0.002914	0.002991864	0.518635017	0.001574244	0.000578	0.0004	0.007309758		1732300.97	0.36	159478.777	12.764
	35	59.1	0.001355158	0.501438661	0.003219	0.002936081	0.518635017	0.001574244	0.0008452	0.0004	0.007840727	2514411.05	2528128.62	0.41	271534.803	21.733
Condition 2-3 88228.47	15	25.3		0.501438661				0.001574244		0.0004	0.006718846		398269.67	0.18	18332.715	1.467
	20	33.8		0.501438661				0.001574244			0.006652351		701072.01	0.24	43027.976	3.444
	25	42.2		0.501438661				0.001574244		0.0004	0.006520397		1073835.31	0.30	82382.692	6.594
	30	50.6		0.501438661				0.001574244		0.0004	0.007271958		1723395.06	0.36	158658.883	12.699
	35	59.1	0.001355158	0.501438661	0.003219	0.002936081	0.518635017	0.001574244	0.001292	0.0004	0.008287527	2657693.53	2671411.10	0.41	286924.123	22.965
Condition 2-4 88228.47	15	25.3		0.501438661				0.001574244		0.0004	0.006860406		406607.77	0.18	18716.525	1.498
	20	33.8		0.501438661				0.001574244		0.0004	0.006745883		710866.10	0.24	43629.084	3.492
	25	42.2		0.501438661				0.001574244		0.0004	0.006867897		1130691.61	0.30	86744.605	6.943
	30	50.6		0.501438661				0.001574244		0.0004	0.007200358		1706525.67	0.36	157105.856	12.574
	35	59.1	0.001355158	0.501438661	0.003219	0.002936081	0.518635017	0.001574244	0.0006966	0.0004	0.007692127	2466757.12	2480474.68	0.41	266416.511	21.324
Condition 2-5 88228.47	15	25.3	0.001499129	0.501438661	0.002629	0.003263452	0.518635017	0.001574244	0.0002086	0.0004	0.006856106	403834.94	406354.49	0.18	18704.867	1.497
	20	33.8		0.501438661				0.001574244		0.0004	0.006808583		717431.66	0.24	44032.042	3.524
	25	42.2	0.001410087	0.501438661	0.002524	0.003059917	0.518635017	0.001574244	0.0004031	0.0004	0.006795397	1111830.75	1118829.51	0.30	85834.566	6.870

APPENDIX D: RESISTANCE CALCULATION TABLE

	30 35	50.6 59.1		0.501438661 0.501438661				0.001574244 0.001574244		0.0004 0.0004	0.007302358 0.007936927		1730557.49 2558978.60	0.36 0.41	159318.269 274848.260	12.752 21.998
Condition 2-6 88228.47	15	25.3	0.001499129					0.001574244		0.0004	0.006722166		398465.22	0.18	18341.716	1.468
	20	33.8 42.2	0.001448028 0.001410087					0.001574244 0.001574244		0.0004 0.0004	0.006653963 0.006606797		701240.81 1087971.67	0.24 0.30	43038.336	3.445 6.681
	25 30														83467.208	
	30 35	50.6 59.1	0.001379686 0.001355158					0.001574244 0.001574244		0.0004 0.0004	0.007271958 0.008350527		1723395.06 2691614.31	0.36 0.41	158658.883 289094.059	12.699 23.139
	33	39.1	0.001333138	0.301438001	0.003219	0.002930081	0.518055017	0.001374244	0.001333	0.0004	0.008330327	2077890.74	2091014.31	0.41	209094.039	23.139
Condition 1-1 99907.89	15	25.3	0.001499129	0.442819538	0.002629	0.003263452	0.534047388	0.001574244	0.0002791	0.0004	0.006889026	405773 97	408293 52	0.18	18794.122	1.409
Conunion 1 199907.09	20	33.8	0.001448028					0.001574244		0.0004	0.007548595		794921.07	0.24	48787.919	3.658
	25	42.2	0.001410087					0.001574244		0.0004	0.007138099		1174900.87	0.30	90136.259	6.758
	30	50.6	0.001379686	0.442819538	0.002914	0.002991864	0.534047388	0.001574244	0.001508	0.0004	0.008204993	1933145.66	1943223.88	0.36	178896.723	13.412
	35	59.1	0.001355158	0.442819538	0.003219	0.002936081	0.534047388	0.001574244	0.0009675	0.0004	0.007928841	2542667.90	2556385.46	0.41	274569.743	20.585
Condition 1-2 99907.89	15	25.3	0.001499129					0.001574244		0.0004	0.006745326		399829.37	0.18	18404.510	1.380
	20	33.8	0.001448028					0.001574244		0.0004	0.007588995		799151.50	0.24	49047.560	3.677
	25	42.2	0.001410087					0.001574244		0.0004	0.006711799		1105151.68	0.30	84785.227	6.356
	30 35	50.6	0.001379686					0.001574244		0.0004	0.007048893		1670839.78	0.36	153820.548	11.532
	35	59.1	0.001355158	0.442819538	0.003219	0.002936081	0.53404/388	0.001574244	0.0003951	0.0004	0.007356441	2359107.26	2372824.83	0.41	254854.329	19.107
Condition 1-3 99907.89	15	25.3	0.001499129	0.442819538	0.002629	0.003263452	0.534047388	0.001574244	0.0003182	0.0004	0.006928126	408077.02	410596.57	0.18	18900.133	1.417
	20	33.8	0.001448028	0.442819538	0.002711	0.003146416	0.534047388	0.001574244	0.001041	0.0004	0.007647795	800829.47	805308.67	0.24	49425.454	3.705
	25	42.2	0.001410087	0.442819538	0.002524	0.003059917	0.534047388	0.001574244	0.0007666	0.0004	0.007123399	1165496.97	1172495.73	0.30	89951.740	6.744
	30	50.6	0.001379686	0.442819538	0.002914	0.002991864	0.534047388	0.001574244	0.0007162	0.0004	0.007413193	1746592.83	1756671.04	0.36	161722.330	12.124
	35	59.1	0.001355158	0.442819538	0.003219	0.002936081	0.534047388	0.001574244	0.00111	0.0004	0.008071341	2588365.65	2602083.21	0.41	279477.930	20.953
G 11.1 4 40000 F 00		25.2			0.000.000							40.5022.05	100055 10	0.40	10506000	
Condition 1-4 99907.89	15	25.3	0.001499129					0.001574244		0.0004	0.006890026		408352.42	0.18	18796.833	1.409
	20	33.8	0.001448028					0.001574244		0.0004	0.007492595		789057.09	0.24	48428.021	3.631
	25	42.2	0.001410087 0.001379686					0.001574244 0.001574244		0.0004	0.007200199 0.008221993		1185061.38 1947229.18	0.30	90915.755 179265.458	6.816
	30 35	50.6								0.0004				0.36		13.440
	33	59.1	0.001355158	0.442819538	0.003219	0.002936081	0.53404/388	0.001574244	0.0009582	0.0004	0.007919541	2539685.52	2553403.09	0.41	274249.419	20.561
Condition 1-5 99907.89	15	25.3	0.001499129	0.442819538	0.002629	0.003263452	0.534047388	0.001574244	0.0001416	0.0004	0.006751526	397675.01	400194.56	0.18	18421.320	1.381
	20	33.8	0.001448028	0.442819538	0.002711	0.003146416	0.534047388	0.001574244	0.001074	0.0004	0.007680795	804285.02	808764.23	0.24	49637.537	3.721
	25	42.2	0.001410087	0.442819538	0.002524	0.003059917	0.534047388	0.001574244	0.0002774	0.0004	0.006634199	1085456.37	1092455.13	0.30	83811.172	6.283
	30	50.6	0.001379686	0.442819538	0.002914	0.002991864	0.534047388	0.001574244	0.0003987	0.0004	0.007095693	1671787.93	1681866.14	0.36	154835.655	11.608
	35	59.1	0.001355158	0.442819538	0.003219	0.002936081	0.534047388	0.001574244	0.000398	0.0004	0.007359341	2360037.25	2373754.82	0.41	254954.215	19.114
Condition 1-6 99907.89	15	25.3	0.001499129	0.442910529	0.002620	0.002262452	0.524047299	0.001574244	0.0002107	0.0004	0.006929626	109165 27	410684 92	0.18	18904.200	1.417
Condition 1-0 2220/.89	20	33.8	0.001448028					0.001574244		0.0004	0.000929020		796784.97	0.18	48902.315	3.666
	25	42.2	0.001448028					0.001574244		0.0004	0.007300393		1169517.93	0.24	89723.289	6.727
	30	50.6	0.001379686					0.001574244		0.0004	0.007103199		1651849.93	0.36	152072.308	11.401
	35	59.1		0.442819538				0.001574244		0.0004	0.000908293		2973437.54		319363.410	
	33	37.1	0.001333138	0.442019330	0.003219	0.002930081	0.55404/566	0.0013/4244	0.002208	0.0004	0.009229341	4737/19.97	4713431.34	0.41	317303.410	43.943

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